

## Taxonomy and Ecology of Costa Rican *Euplectrus* (Hymenoptera: Eulophidae), Parasitoids of Caterpillars (Lepidoptera)

MICHAEL E. SCHAUFF AND DANIEL H. JANZEN

(MES) Systematic Entomology Laboratory, Agricultural Research Service, Plant Sciences Institute, c/o National Museum of Natural History, Washington, D.C. 20560-0168, USA (e-mail: mschauff@sel.barc.usda.gov); (DHJ) Department of Biology, University of Pennsylvania, Philadelphia, PA 19104, USA (e-mail: djanzen@sas.upenn.edu)

---

*Abstract.*—The species of parasitic wasps in the genus *Euplectrus* (Hymenoptera: Eulophidae) known from Costa Rica are reviewed, and their ecology is briefly summarized from a long-term on-going inventory of caterpillars (Lepidoptera) and their parasitoids in the Area de Conservación Guanacaste in northwestern Costa Rica. Twenty species are reported, of which 17 are new species described by Schauff: *Euplectrus anae*, *E. carlowae*, *E. edithae*, *E. floryae*, *E. hansonii*, *E. ireneae*, *E. ivonae*, *E. josei*, *E. magdae*, *E. mariaae*, *E. orias*, *E. rojasi*, *E. romiceii*, *E. valverdei*, *E. waltheri*, *E. xiomarae* and *E. zamorai*. An illustrated key and photographs of larvae supplement the descriptions.

---

Members of the genus *Euplectrus* (Hymenoptera: Eulophidae) are parasitoids on many species of caterpillars that live and feed exposed on the foliage of their food plants (Ferriere 1941, Bouček 1988). Some species have been used in biological control (Puttler *et al.* 1980). The wasps' ability to arrest host caterpillar molting by injecting a chemical arrestant through the ovipositor prior to egg laying also has potential as a tool in pest control (Coudron and Puttler 1988, Coudron and Brandt 1996). In spite of its potential value to agriculture and intriguing natural history, *Euplectrus* has not been studied in any comprehensive manner. This is the first in a series of studies anticipated on the systematics of the New World species of *Euplectrus*. It is intended to alert field biologists about their distinctive ecology.

Very little is known of the systematics of the Central American species of this genus, and almost nothing has been published on their ecology/ life history. An unpublished Ph.D. thesis discussed the New World species and contains records of several Central American species (Gon-

zalez 1985). But, since this thesis has remained unpublished, these records remain unavailable. DeSantis (1967), DeSantis (1979), and DeSantis (1980), DeSantis and Fidalgo (1994) cataloged the 21 species that have been described from Central and South America. Only three species were recorded from Costa Rica (*E. cosmtockii*, *E. furnius*, and *E. solitarius*) and we describe 17 new ones in the paper.

As is often the case in chalcidoid wasps, host records for *Euplectrus* have been scattered and are of questionable accuracy. However, extensive rearing of Lepidoptera larvae for the past two decades (<http://janzen.sas.upenn.edu>) as a caterpillar inventory of the biodiversity of the Area de Conservación Guanacaste (ACG) in northwestern Costa Rica (<http://www.acguanacaste.ac.cr> and Janzen 2000) has generated more than 250 *Euplectrus* rearings, along with those of other parasitoids (e.g., Gauld *et al.* 1992, Janzen 1993, Gauld and Janzen 1994, Sharkey and Janzen 1995, Dangerfield *et al.* 1996, Janzen, D. H. and I. D. Gauld 1997, Zitani *et al.* 1997, Janzen *et al.* 1998). In addition, P. Hanson

of the Universidad de Costa Rica and I. D. Gauld of The Natural History Museum have extensively malaise trapped the parasitoid fauna in Costa Rica, and this material is considered here as well. As a result of these efforts, we are now able to report in a detailed manner on the composition of this genus over a large area of many habitats. Although this study expands the number of species known from Costa Rica by about 500%, we feel that many more species remain to be discovered. *Euplectrus* appear in Malaise traps with very low frequency, so that their presence will have to be detected largely through rearing programs.

Among Eulophidae, the tribe Euplectrini is one of the most easily identifiable since all species share the greatly elongated hind tibial spur(s) (Fig. 89) that have been the defining synapomorphy for the group since the last century (Bouček 1988, Wijesekara and Schauff 1994). Species of *Euplectrus* can be differentiated from other genera in the Euplectrini by having a simple median carina on the propodeum, lacking submarginal grooves on the scutellum, and having only 2–3 pairs of setae on the mesoscutal midlobe and spinning a cocoon as illustrated in Figs. 1–9. A key to New World genera was published by Wijesekara and Schauff (1997).

*Euplectrus* (Fig. 4) is also unique among Eulophidae in that the larvae live externally on the host and spin a cocoon in which to pupate. Equally unique, the cocoon silk is produced from the anus by modified malpighian tubules (Ferrière 1941). The eggs are laid externally in groups on the host caterpillar. The larvae feed on hemolymph through the cuticle and mature while attached to the back of the host by their mouthparts (Figs. 1, 5, 6, 8). When ready to pupate, the larvae of some species move to the underside of the caterpillar cadaver (Figs 2, 3, 9), while others spin a ruff of cocoons around the cadaver.

Below, we describe the species of *Eu-*

*plectrus* (the senior author is the taxonomic author of these species), and give an account of the natural history for those on which we have been able to accumulate data.

Abbreviations of museums are as follows: U.S. National Museum of Natural History, Washington, D. C. (USNM); The Natural History Museum, London (BMNH); Instituto Nacional de Biodiversidad (INBIO), Costa Rica; Canadian National Collection, Ottawa (CNC).

High resolution digital copies of the original photographs for Figures 1–9, all taken in the Area de Conservación Guanacaste, are available at Janzen and Hallwachs (2000).

*Morphology.*—One of the distinctive features of species of *Euplectrus* is the arrangement of small and enlarged setae on the head (Fig. 23). There are up to six pairs of thickened and elongated setae on the upper part of the head. There are two pairs postero-laterally along the occipital carina (S1 and S2). There is a pair between the posterior ocelli (S3) and a pair laterad of the anterior ocellus (S4). S5 lies on the vertex forward of S4 and between the top of the scrobes and the eye. S6 is located near the edge of the eye about 1/2 way down the orbit. In all the species examined to date, S1, S2, S3, and S6 are always present. S4 and S5 may be either reduced or absent.

In addition to the enlarged setae, there are also several smaller setae, some of which occur in pairs (Fig. 23). There is generally a row of setae behind the eye and below the occipital carina (sr1). There is a pair of small setae (ss1) near the occipital carina between S1 and S2. Between and slightly behind the posterior ocelli are one or two pairs of small setae (ss2) that are occasionally absent. Laterad of S4 there is a single small seta (ss3) and laterad and below S6 there is an irregular line of setae (sr2) that usually extends to the bottom of the eye.

The antenna has four funicular seg-

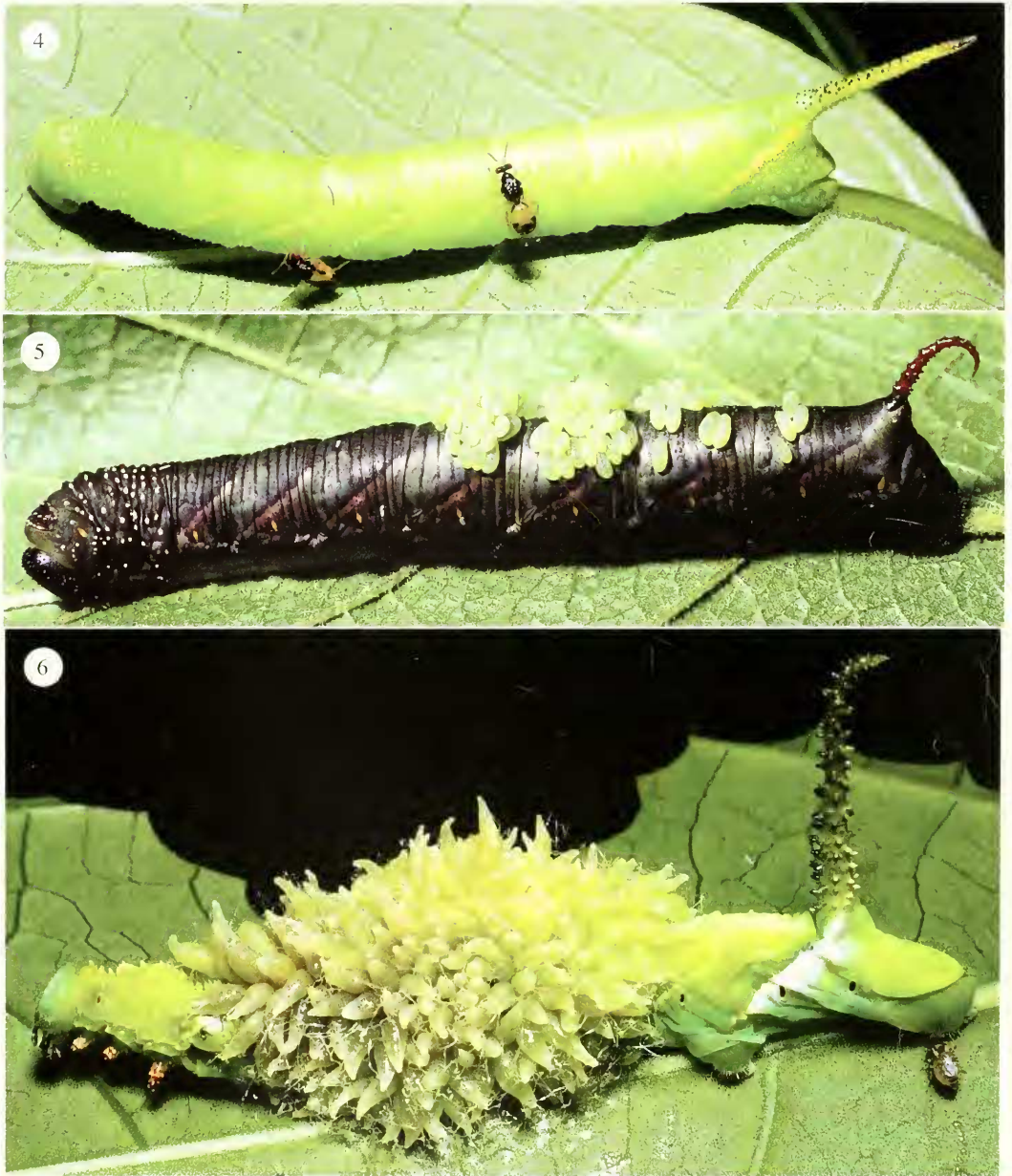




Figs. 1-3. Lepidopteran larvae attacked by *Euplectrus*. 1, A normal size clutch of *E. floryae* larvae feeding on body fluids of a pen-penultimate (third) instar of *Enyo ocypte* (Sphingidae). All species of *Euplectrus* for which the larvae are known except *E. walteri* (Figs. 4-7) display this general appearance on their host caterpillars (e.g., Fig 8); 2, The mummified cadaver of an ultimate (fifth) instar *Paectes lunodes* (Noctuidae) caterpillar after the larvae of *E. joesi* have terminated their feeding on it and spun cocoons between the cadaver and the leaf, firmly silking/gluing the cadaver to the cocoons (see Fig. 3). Fourteen spheroidal meconial pellets from 14 wasp larvae surround the cadaver. This is the pupation method used by all species of *Euplectrus* known except for *E. walteri* (Figs. 4-7); 3, The side-by-side and often head-to-toe cocoons/pupae of 16 *E. joesi* after the mummified cadaver of their host caterpillar (and see Fig. 2) has been stripped away. When exposed in this manner, the pupae often die of apparent desiccation unless placed in a high-humidity container.

ments (F1-F4) followed by a club or clava (Fig. 25). The female scape is cylindrical and 4-6× as long as wide. The male scape shows great variation from cylindrical (as

in females) to greatly enlarged and balloon-like (Fig. 50). All male scapes possess groups of sensillae which appear as round clear areas in slide-mounted specimens



Figs. 4-6. Sphingid larvae attacked by *Euplectrus walteri*. 4, Two females waiting to oviposit after this penultimate (third) instar *Manduca barnesi* has molted to penultimate instar, the instar usually parasitized by *Euplectrus walteri* when attacking the larger of the species of *Manduca*. This caterpillar was within 24 hours of molting. The wasps clung tenaciously to the caterpillar despite being banged around in a plastic bag and roughly transported from the forest to the laboratory where the photograph was taken. 5, One or several clutches of partly grown *Euplectrus walteri* larvae feeding on an ultimate instar *Manduca dilucida* (dark morph). 6, A clutch of full-grown larvae just beginning to spin the first strands of silk of their aggregate cocoon on the back of a just-died penultimate (fourth) instar *Manduca florestan*. The distended ceratopogonid fly sucking caterpillar blood on the far right is *Forcipomyia* prob. *fuliginosa* (Art Borkent, pers. comm.).



(Figs. 19–21). The patterns of these sensillae along with the shape of the scape is often species-specific (Figs. 27–39).

Abbreviations for measurements and ratios are as follows (Figs. 23, 24): OD: OOD is the longest ocellar diameter compared to the distance between the ocellus and the eye (ocell-ocular distance); FW: EW is the ratio of the width of the face (distance between the margins of the eyes at the midpoint) to the width of the eye (distance from the margin of the eye to the edge of the eye when viewed from the front of the head). Height of the eye (EH) is the distance from the bottom of the eye to the top of the eye when viewed either from the front or laterally. The malar space (MS) is the distance from the bottom of the eye to the oral opening.

*Rearing.*—Wild-caught caterpillars were individually reared and databased as part of an ongoing inventory (<http://janzen.sas.upenn.edu> and Janzen and Hallwachs 2000) of all the caterpillars of the dry forest, cloud forest, and rain forest of the Area de Conservación Guanacaste (ACG) in northwestern Costa Rica (<http://www.acguanacaste.ac.cr>). Each caterpillar was maintained in a plastic bag or glass bottle at ambient temperatures while it and/or its parasitoids developed. When parasitoids appeared, or in this case, when the *Euplectrus* larvae were noted on the caterpillar, the caterpillar was isolated in a glass bottle with a small amount of food plant as a perch, to maintain humidity and serve as a substrate for the cocoon-spinning of the *Euplectrus* larvae. *Euplectrus* cocoons were monitored daily, and when the wasps eclosed, they were preserved in alcohol for later shipment to the senior author. *Euplectrus* adults were noteworthy for generally living at least 48 hours in the rearing container before dying (of starvation?) while other similarly-sized Eulophidae, Braconidae and Ichneumonidae rarely survive more than 24 hours in the rearing container without being fed.

This methodology of caterpillar and

parasitoid surveying suffers the limitation that once the caterpillar has been found in nature and brought into captivity, it and its parasitoids are no longer available for parasitization or hyperparasitization. This means that the percentages of parasitization recorded here represent the minimal possible. Equally confounding is that caterpillars are captured at all stages in their development, with the result that a simple comparison of the number of caterpillars parasitized against the number of caterpillars captured may severely underestimate the intensity of parasitization. This underestimation is because in the case of some species of *Euplectrus*, the wasp larvae kill the caterpillars during instars prior to the last instar. The number of “unparasitized” later instars found is therefore meaningless vis-a-vis *Euplectrus* percent parasitization. It should be emphasized that all sphingid caterpillars that have been found in the wild in the inventory are captured and reared in captivity, so there is no bias generated through seeking just those individuals parasitized by *Euplectrus*.

There were two kinds of *Euplectrus* identifications produced in this study. The most certain are those where wasps eclosed. All of those were identified by the senior author, a eulophid taxonomist. In 20–30% of the cases of parasitization by the uniquely distinctive external green larvae of *Euplectrus* (Fig. 1), the wasp larvae died when attempting their relocation below the cadaver or died because of severe rearing conditions (excessive heat, moisture, desiccation). For *Euplectrus floryae*, *E. walteri*, *E. mariae* and *E. josei*, the junior author (a *Euplectrus* ecologist) identified those dead larvae based on their distinctive cocoons, timing of attack, and taxon of host. These identifications are pooled with those of the senior author when attempting to tease out the intensity of attack and certain questions of parasitoid host specificity, but may also be treated as two separate classes of data at the wishes of the reader, since each record is individually documented in the da-

tabase and the identifier identified (<http://janzen.sas.upenn.edu>).

The basic collection locality and date information for all the reared *Euplectrus* de-

scribed here (Table 1) is deliberately minimal. More detailed information on a particular rearing may be found at <http://janzen.sas.upenn.edu>.

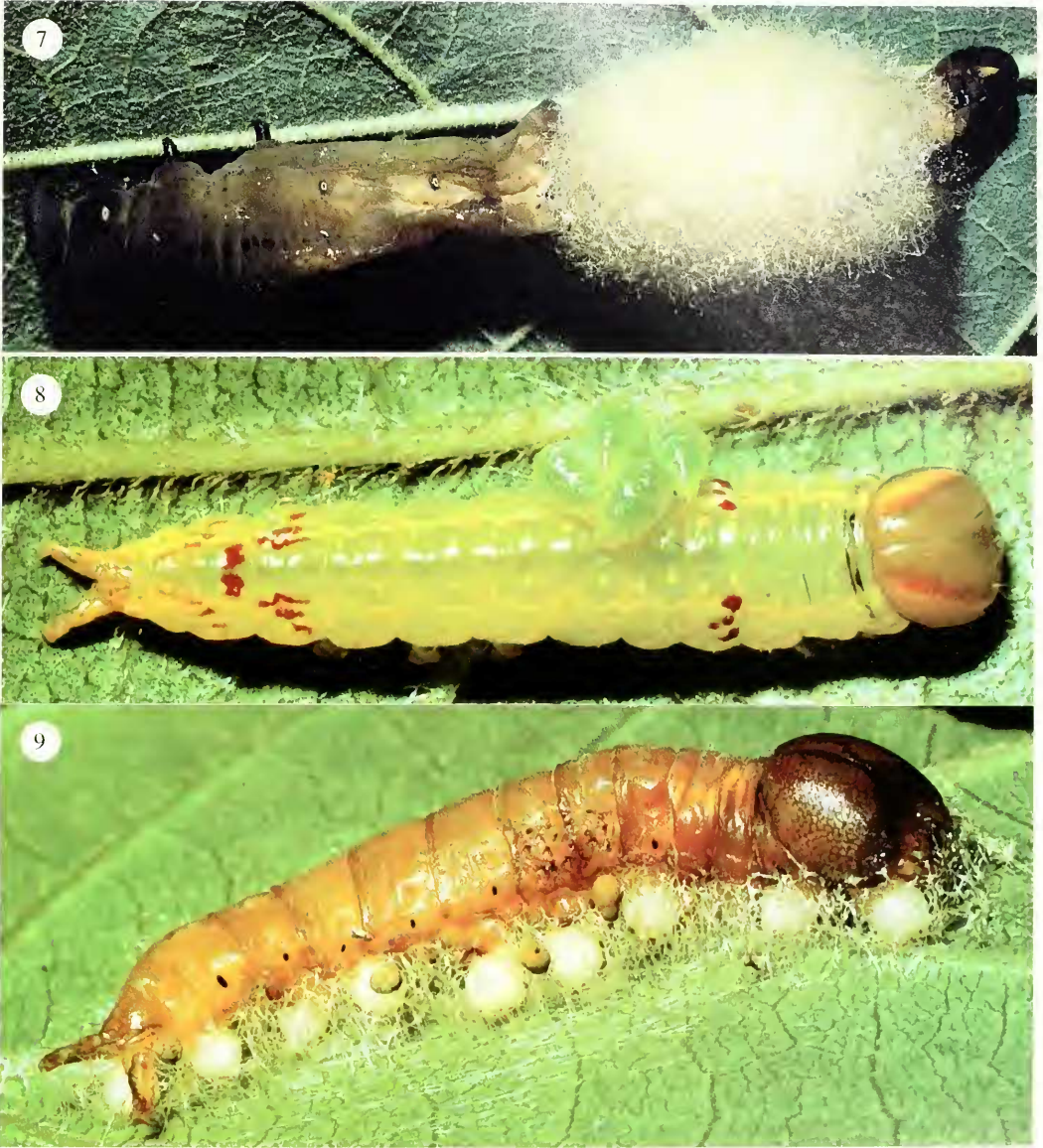
Table 1. Host associations for the 11 new species of reared *Euplectrus* described here from the ACG. All records are from wild-caught caterpillars of the species indicated. Details may be found in the individual records in Janzen and Hallwachs (2000).

<i>Euplectrus</i> species	Host	Number of hosts parasitized	Number susceptibles reared	% Parasitized
<i>anae</i>	<i>Sphacelodes vulneraria</i> (Hubner) (Geometridae)	1	197	0.5
<i>floryae</i>	<i>Enyo ocypte</i> (L.) (Sphingidae)	84	1010	8.3
	<i>Perigonia ilus</i> Boisduval (Sphingidae)	17	256	6.6
	<i>Perigonia lusca</i> (F.) (Sphingidae)	2	73	2.7
	<i>Aellopos fadus</i> (Cramer) (Sphingidae)	4	256	1.6
<i>ireneae</i>	<i>Motyia absenzalis</i> (Walker) (Noctuidae)	1	29	3.5
<i>ivonae</i>	<i>Euscirrhopterus poeyi</i> Grote (Noctuidae)	1	174	0.6
<i>josei</i>	<i>Paectes lunodes</i> (Guenée) (Noctuidae)	11	73	15.0
<i>magdae</i>	<i>Dasylophia maxtla</i> (Shaus) (Notodontidae)	1	29	3.1
	<i>Dasylophia basitincta</i> Dognin (Notodontidae)	1	65	1.3
	<i>Dasylophia</i> nr. <i>goraxa</i> Schaus (Notodontidae)	1	12	8.3
<i>mariae</i>	<i>Concina mundissima</i> Walker (Noctuidae)	30	194	15.5
	<i>Elymiotis attenuata</i> (Walker) (Notodontidae)	7	213	3.3
	<i>Dasylophia</i> nr. <i>goraxa</i> Schaus (Notodontidae)	1	12	8.3
<i>orias</i>	Geometridae	1	1885	0.05
<i>romiei</i>	<i>Oxidercia toxca</i> (Stoll) (Noctuidae)	1	91	1.2
	<i>Cantethia spuria</i> (Boisduval) (Sphingidae)	1	110	0.9
<i>walteri</i>	<i>Manduca barnesi</i> (Clark) (Sphingidae)	1	34	2.9
	<i>Manduca dilucida</i> (Edwards) (Sphingidae)	4	112	3.6
	<i>Manduca florestan</i> (Cramer) (Sphingidae)	19	163	11.7
	<i>Manduca lanuginosa</i> (Edwards) (Sphingidae)	3	68	4.4
	<i>Manduca rustica</i> (F.) (Sphingidae)	3	26	11.5
	<i>Perigonia ilus</i> Boisduval (Sphingidae)	1	181	0.5
<i>xiomarae</i>	<i>Hemiceras clarki</i> (Notodontidae) Schaus	6	183	3.3
	<i>Hemiceras corema</i> Schaus (Notodontidae)	1	71	1.4
	<i>Hemiceras nigrescens</i> Schaus (Notodontidae)	1	521	0.2
	<i>Rosema attenuata</i> (Notodontidae)	14	111	12.6

#### KEY TO SPECIES OF COSTA RICAN EUPLECTRUS

1. Either face beneath toruli marked light brown or black (Fig. 15) or hind coxae brown to black (Fig. 11) ..... 2
  - Face beneath toruli all yellow (Figs. 12, 13, 16) and hind coxae light yellow or white (Fig. 10) ..... 9
2. Apical flagellomeres dark and contrasting with yellow to light brown F1 (Fig. 22) ..... 3
  - Apical flagellomeres same color as F1 or only slightly darker ..... 4
3. Width of face about 4X width of eye viewed from front (to measure FW:EW, see Fig. 24); posterior ocellus about 2X its own diameter removed from the margin of the eye (Fig. 49); mandibles yellow, male scapes greatly swollen (Fig. 50) ..... *furnius* Walker
  - Width of face about 2.5X width of eye viewed from front; posterior ocellus about 1.25X or less its own diameter removed from margin of eye; mandibles brown, male unknown ..... *zamorai*, new species





Figs. 7–9. Lepidopteran larvae attacked by *Euplectrus*. 7, The aggregate cocoon of a clutch of 100–200 *Euplectrus walteri* pupae ringing the semi-decomposed mummy of an ultimate (fifth) instar *Manduca dilucida* that was their host. The ruff of cocoons is a single dense unit with the cocoons tightly packed together and bound together by silk and glue. This is the only species of *Euplectrus* known to make an aggregate cocoon of this nature. 8, A normal-sized clutch of *E. xiomarae* larvae feeding on body fluids of a penultimate (fourth) instar *Hemiceras clarki* (Notodontidae). 9, The mummified cadaver of a penultimate (fourth) instar *H. plicatus clarki* (Notodontidae) caterpillar after the larvae of *E. xiomarae* have terminated their feeding on it and spun cocoons between the cadaver and the leaf, firmly silking/glueing the cadaver to the cocoons. Three beige spheroidal meconial pellets are suspended on the outer surface of the silk aggregate cocoons. This is the pupation method used by all species of *Euplectrus* known except for *E. walteri* (Figs. 4–7).

4. Hind coxa yellow or very light brown (Fig. 10) ..... 5
  - Hind coxa dark brown or black (Fig. 11) ..... 6
5. First tarsomere of hind leg about equal in length to second; postero-lateral margin of scutellum overlapping metanotum (Fig. 43) ..... *carlowae*, new species
  - First tarsomere of hind leg much longer than second; postero-lateral margin of scutellum not overlapping metanotum ..... *edithae*, new species
6. Posterior margin of scutellum overlapping anterior edge of metanotum medially (Fig. 68, 69); anterior median propodeal carina split into a V-shape, not enlarged and cup-like (Fig. 69) ..... *rojasi*, new species
  - Posterior margin of scutellum not overlapping anterior edge of metanotum medially, at least two distinct alveoli visible at anterior edge of metanotum (Figs. 53, 59); anterior median propodeal carina expanded and protruding from surface of propodeum, invaginated and cup-like (Figs. 42, 43) ..... 7
7. One pair of small setae (ss2) present between lateral ocelli (Figs. 66, 82) .. *orais*, new species
  - No small setae (ss2) between lateral ocelli (Fig. 85) ..... 8
8. Mandibles brown; malar suture present at least below eye margin (as in Fig. 67) ..... *valverdi*, new species
  - Mandibles yellow; malar suture absent ..... *xiomarae*, new species
9. Occiput between posterior ocelli with 2 pairs (4) of small setae (ss2) (Fig. 46) ..... 10
  - Occiput between posterior ocelli with 1 pair (2) or no small setae (ss2) (Fig. 49) ..... 11
10. Yellow color on face extending about 1/2 way up eye margin and above level of toruli (Fig. 12) ..... *floryae*, new species
  - Yellow color on face restricted to below and between toruli, not extending up along margin of eye (as in Figs. 13, 14) ..... *josei*, new species
11. Posterior ocellus less than 1 diameter from edge of eye (see Fig. 23); width of eye more than 1/2 width of face (Fig. 24) ..... *irenae*, new species
  - Posterior ocellus more than 1 diameter from edge of eye; width of eye less than 1/2 width of face ..... 12
12. Toruli separated by about 4X their own diameter (Fig. 13). ..... *walteri*, new species
  - Toruli separated by about 2–2.5X their own diameter ..... 13
13. Funicular segments F1–4 all about 3X as long as wide and F1–3 all about same length as club (Fig. 26) ..... *hansoni*, new species
  - At least one of funicular segments F1–4 less than 3X as long as wide, generally only 2X as long as wide or less; F2–4 usually much shorter than club ..... 14
14. Enlarged seta number 5 (S5, Fig. 23) present ..... 15
  - Enlarged setae number 5 absent ..... 18
15. Anterior metanotum with a single large alveolus, sometimes divided medially into two large alveoli (Fig. 59); propodeum distinctly reticulate over entire median surface ..... *madgae*, new species
  - Anterior metanotum with a thin line of small alveoli (Fig. 40); propodeum not distinctly reticulate over surface, usually lightly reticulate or smooth and shiny ..... 16
16. Petiole distinctly wider than long; propodeum adjacent to median carina with irregular small carinae, appearing rugose; metasoma light brown to brown in apical half ..... *anae*, new species
  - Petiole as long as wide or longer than wide; propodeum adjacent to median carina smooth or very lightly reticulate; metasoma dark brown to black apically ..... 17
17. F1 about 3X as long as wide ..... *solitarius* Ashmead
  - F1 about 2X as long as wide ..... *constockii* Howard
18. Yellow coloration of face extending laterally beyond the outer edge of the toruli, often reaching to under the eye (Fig. 16) ..... *ivonae*, new species
  - Yellow coloration of face restricted to between and below the toruli, occasionally slightly laterad of the toruli, but not to near or under eye ..... 19
19. Propodeum immediately laterad of median carina with small irregular carinae (appearing



- somewhat rugose) or lightly reticulate; petiole wider than long. Male scape with small brown sensory area on ventral edge which extends at most (2/3 or more) of length of scape (Fig. 30) with 2–3 irregular rows of sensillae ..... *mariae*, new species
- Propodeum laterad of median carina mostly smooth; petiole as wide as long. Male scape with small brown sensory area on ventral edge which extends for less than 1/2 length with only a single row of sensillae (Fig. 31) ..... *ronniei*, new species

ECOLOGY

*Euplectrus floryae* Schauff.—This species is a common parasitoid (Table 1) of second instar *Enyo ocypte* (Sphingidae), a medium-sized caterpillar that feeds on Dilleniaceae in the dry forests of the ACG (Fig. 3). It is likely that this small sphingid supports most of the *Euplectrus floryae* population in these forests. This *Euplectrus* has not been found in any of the ACG rain forest or cloud forest. Parasitized *Enyo ocypte* larvae have been found feeding on *Tetracera volubilis* L. and *Curatella americana* L. This sphingid feeds also on *Davilla kunthii* A. St.-Hil. and *Doliocarpus deutatus* but in such low numbers that the absence of *Euplectrus floryae* records on these caterpillar food plants may be a sampling artifact. The parasitized *Enyo ocypte* caterpillars were found in sites ranging from fully isolated habitats (mostly *Curatella americana*) to the deep shade of old-growth forest (mostly *Tetracera volubilis* L.).

Only one *Enyo ocypte* wild-caught first instar was found to have *Euplectrus floryae* on it, and that one died without its three parasite larvae completing development (92-SRNP-835). However, many *Enyo ocypte* larvae have been found in nature as second and third instars with *Euplectrus floryae* feeding on them. Only two fourth and no fifth (last) instar *Enyo ocypte* larvae have been found with *Euplectrus floryae* on them. These records imply that once the caterpillar has reached the penultimate or last instar, it is immune or unattractive to the wasp adult. It appears that oviposition normally occurs on second or third instar larvae. A single caterpillar normally supports 5–10 *Euplectrus floryae* larvae in a single group. We as-

sume that this represents a single oviposition by a single female.

There is no suggestion that the sphingid caterpillar molts after wasp oviposition occurs. The wasp larvae develop from minute, glabrous, green protuberances in a cluster to a tight cluster of large globular green larvae (Fig. 3) at the same point on the back over a period of 4–8 days. They do not move about and feed with their heads always inserted in the same hole. The caterpillar does continue to eat leaves during this period, but stops feeding in 1–2 days before the wasp larvae release their feeding position and move to underneath the moribund caterpillar to spin their cocoons on the leaf underside (e.g. Figs. 2, 3) (where the caterpillar also rests when unparasitized). The beige/brown silk cocoons are adjacent with their long axis at right angles to the long axis of the caterpillar, alternately oriented to the left and right, with the meconial pellet clearly visible at the tip of the cocoon. The cocoons are tightly glued between the ventral surface of the cadaver and the leaf. The cocoons are enmeshed in a distinctive silken matrix resembling a loose basket. The cadaver becomes a mummified strap of tissue perched on top of the cocoons.

The wasps spend 7–12 days in their cocoons. However, while wasp eclosion date is accurately recorded (see text account of specimens examined), some of the shorter development times of 7 days may be cases where the cocoons were not noticed for 1–2 days after they were spun. It is likely that the usual time in the cocoon is about 8 days. There is no evidence of dormancy by pupae in cocoons spun at any time in the rainy season. Only once has a caterpillar parasitized by *Euplectrus floryae* been

found in the dry season, and in this case there was no indication of dry season dormancy (92-SRNP-524).

The overall phenology of *Enyo ocypte* second and third instars in this dry forest habitat is that they first appear on *Curtella americana* L. in small numbers in February–April, and then in much larger numbers in May–June. In June–July, there are large numbers on *Tetracera volubilis* L., followed by a very few individuals on both species of plants through December. One *Euplectrus floryae* record is in February and one at the end of September. As a general pattern, it appears that the *Euplectrus floryae* population could have as many as 4–5 consecutive generations on the *Enyo ocypte* population beginning in early May–July. It survives the August-to-April last half of the rainy season and nearly all of the dry season as non-reproducing adults. It is unknown whether they migrate to a wetter part of Costa Rica, or “hide” in local moist areas within the dry forest. They do not appear in Malaise traps at any time of the year, even when these traps are in the middle of the forest habitats in which they are breeding, only a few meters from parasitized caterpillars. The overall results of the caterpillar rearing program in this forest suggests that *Euplectrus floryae* does not use an alternate host caterpillar species or family at these other times of the year.

The few records of *Euplectrus floryae* from *Cautethia spuria*, two records from *Aellopos fadus*, and 18 records from *Perigonia ilus* and *Perigonia lusca* (these two species are nearly indistinguishable as larvae) (Table 1), probably represent minority hosts for *Euplectrus floryae*. These four sphingids suffer no more than 2% parasitization by *E. floryae*, while, for example, of 200 larvae of *Enyo ocypte* collected in the second and third instars (the key susceptible stages), 25% had *Euplectrus floryae* on their backs. The parasitization of non-*Enyo ocypte* caterpillars occurs at the same time of year (the first half of the rainy season)

as do the bulk of the rearing records from *Enyo ocypte*.

*Euplectrus floryae* is essentially the only hymenopterous parasite in the ACG dry forest habitat that kills *Enyo ocypte* prior to the last instar (except for two braconid rearings and one ichneumonid from 1240 caterpillars). The other parasitoids of *Enyo ocypte* are two species of Tachinidae; their larvae emerge from the caterpillar at the end of the last instar (*Drino piceiventris*) or the adult fly ecloses from the pupa (*Belvosia* sp.). While this forest has thousands of species of hymenopterous and dipterous parasitoids of caterpillars, *Euplectrus floryae* shares *Enyo ocypte* with only two of them. The two fly parasites may get into their hosts as early as the second instar, but more commonly do so in the 3–5th instars. In effect, *Euplectrus floryae* utilizes its portion of the host population early in caterpillar development, and then the tachinid flies take their portion after that.

The four species of dilleniaceous plants used by *Enyo ocypte* in this dry forest habitat are also fed on by caterpillars of the small sphingids *Aleuron iphis*, *Unzela japix*, *Unzela pronoe*, and *Pachygonidia drucei*. However, of a total of 463 caterpillars of these species reared to date, none were parasitized by *Euplectrus*. These plants are also fed on by five species of Noctuidae, and no *Euplectrus* have been found on these caterpillars.

In summary, *Euplectrus floryae* is unambiguously a specialist on *Enyo ocypte* in this dry forest, but it uses at least four other species of very abundant sphingid caterpillars, none of which feed on the *Enyo ocypte* host plants, at a low frequency. It is “ignoring” in some sense at least 50 other species of sphingid caterpillars and a thousand or more species of other caterpillars whose size would not preclude successful *E. floryae* development in this dry forest habitat. Like all other *Euplectrus* reared in the ACG, it has never been found in rainforest or cloud forest, either with traps or by rearing.



*Euplectrus ireneae* Schauff.—This species has been reared only once out of 29 rearings, from a rare and highly seasonal small green noctuid caterpillar, *Motya abseuzalis* L. This caterpillar feeds on the leaves of *Conocarpus erecta* (Combretaceae) during the second month of the rainy season in the ACG dry forest at the edge of the coastal mangrove forest. *Euplectrus ireneae* uses its last instar caterpillar host the same way as does *Euplectrus mariae*. This host caterpillar, and the other caterpillars on the edges of the ACG mangrove swamps, have not yet been censused sufficiently to be able to say anything about the relative abundance or specificity of *Euplectrus ireneae*.

*Euplectrus iconae* Schauff.—This species has been reared only twice out of 174 rearings of an extremely abundant and highly seasonal noctuid *Euscirrhopterus poeyi*. This caterpillar feeds on *Pisonia macranthocarpa* Donn.-Sm. (Nyctaginaceae) only during the first week before and after the rainy season begins. This small eulophid wasp may either occur at an extraordinarily low density or it normally uses some other species of caterpillar that has not yet been censused in the caterpillar inventory and feeds on some other host plant *Euscirrhopterus poeyi* Grote and two very low density leaf-rolling pyralids, *Psara hesperialis* and *Psara prunivides*, are the only species of caterpillars feeding on *Pisonia macranthocarpa* Donn.-Sm. in the ACG dry forest.

*Euplectrus josei* Schauff.—This species has a relationship to its sole host, *Paectes lunodes* (Noctuidae), that is essentially identical to that of *Euplectrus mariae* to its primary host.

*Euplectrus magdae* Schauff.—This species occurs at very low density on *Dasylophia* spp. (Notodontidae) in dry forest (Table 1). It shares this host genus with *Euplectrus mariae*, which is much more abundant, however on other caterpillars.

*Euplectrus mariae* Schauff.—This species appears to be a monophagous specialist

on penultimate instar larvae of *Concana mundissima*, a medium-small noctuid that feeds on three species of Malpighiaceae (*Byrsonima crassifolia* (L.) Kunth in HBK, *Hiraea reclinata* Jacq., *Heteropterys laurifolia* (L.) A. Juss. in the ACG dry forest and on penultimate instar *Elymiotis attenuata* (Notodontidae) also feeding on Malpighiaceae (Table 1). The few records of parasitizing last instar larvae may be correct, or may have been penultimate instar larvae. Its biology of host use is essentially identical to that of *Euplectrus floryae*, except that *Euplectrus mariae* has been found only in the May–June first two months of the rainy season (*Concana mundissima* also breeds almost entirely during the first three months of the rainy season). There is no hint of pupal dormancy by *Euplectrus mariae*, so we assume that it passes the remainder of the year as a reproductively dormant adult or migrates to a wetter area to the east to have further generations.

There are 37 records of *Euplectrus mariae* from about 150 suitable-sized caterpillars of *Concana mundissima* captured to date. No other noctuid caterpillar resembling, or taxonomically similar to, *Concana mundissima* is attacked by any species of *Euplectrus* in this forest. This small *Euplectrus* (5–10 larvae per caterpillar) could conceivably parasitize any one of at least a thousand species of caterpillars living in the habitat of *Concana mundissima*.

*Euplectrus mariae* shares *Concana mundissima* with 4 species of microgastrine braconid wasps and four species of tachinid flies. All together, these parasitoids take about 35% of the *Concana mundissima* caterpillars (which is exceptionally high for this inventory), and *Euplectrus mariae* is responsible for about half of this caterpillar mortality.

*Euplectrus walleri* Schauff.—This is a low frequency parasitoid of penultimate (usually) and ultimate (rarely) larvae of various species of *Mimica* (Sphingidae) (Table 1). There has been one or more rearing of *Euplectrus walleri* from all five of the

common *Manduca* species in the ACG dry forest. The absence of *Euplectrus walteri* from the two rare species (*Manduca sexta*, *Manduca hannibal*) is probably due to the very low numbers of these caterpillars found to date. The single record of *Euplectrus walteri* from 381 caterpillars captured of *Perigonia ilus* undoubtedly represents an "abnormal" host record. These records indicate that either *Euplectrus walteri* is ignoring the more than 50 other species of sphingid caterpillars in this habitat (more than 15,000 rearing records), or is unable to develop in them (though the single *Perigonia ilus* record implies that the latter is unlikely). The larvae and cocoons of *Euplectrus walteri* are so distinctive that it can be stated with certainty that they are not using the caterpillars of any other species in the ACG dry forest (based on a sample of more than 50,000 caterpillars large enough to potentially host at least a small group of *Euplectrus walteri* larvae)

A single *Euplectrus walteri* (Fig 4) lays up to several hundred eggs on the back of a (usually) penultimate instar *Manduca*, and the larvae develop into a large patch of fat elongate green larvae tightly packed into one feeding area (Fig 6). In all cases, all the larvae have been bunched together in one place, as if all the eggs were laid there by a single female. In the one case of oviposition observed, there were two females on the caterpillar (Fig 4) but only one was observed to oviposit. As with other *Euplectrus* larvae, they are strongly attached to the caterpillar cuticle by their mouthparts. Before the end of the caterpillar's penultimate instar they have developed to full size, released their hold, and spread into a ruff around the moribund caterpillar as they spin their cocoons (Fig. 7). The cocoons are stuck to one another and constitute a tight brown thick ruff around the caterpillar, which is dead but still clinging to the host plant leaf by the proleg crochets. When rearing this species, it is important not to disturb the caterpillar or wasp larva at the time that

they release their hold on the caterpillar and move to their spinning site, as they easily fall off the caterpillar, become disoriented, and die. The wasps eclose over a 1–2 day period 10–14 days after spinning. There has been no suggestion of pupal dormancy during any of the 16 rearings.

*Euplectrus walteri* has been found parasitizing *Manduca* from June through November. *Manduca* caterpillars are absent from the ACG dry forest habitat for the other months of the year and are extremely rare after July. Either they pass the end of the rainy season and the dry season as reproductively dormant adults, or they migrate to the wetter portions of the ACG and points further to the east in the Caribbean lowland rainforest. However, we favor the former hypothesis since there are to date neither rearings nor Malaise trap records of *Euplectrus walteri* from any wet portion of Costa Rica.

*Euplectrus walteri* occurs at low frequency (32 cases out of more than 230 penultimate instar records), and shares its *Manduca* hosts with a microgastrine braconid (*Microplitis* sp.), three species of ichneumonidae (Janzen and Gauld 1997), and six species of Tachinidae in the ACG dry forest. It is important to recall that if the caterpillar is collected prior to the penultimate instar, it cannot have *E. walteri* in it. In the three cases where *Euplectrus walteri* appeared to have attacked a last instar caterpillar, it could either be an exceptional record or the caterpillar was incorrectly determined to be a last instar.

In addition to being the largest of the *Euplectrus* species reared in this study, *Euplectrus walteri* produces 10–20 times the number of wasps per caterpillar attacked as do the other species, and attacks the largest caterpillars known to be attacked by any species of *Euplectrus*. *Euplectrus walteri* also uses 3–6 days longer in the pupal stage than do the other smaller species of *Euplectrus*.

*Euplectrus xiomarae* Schauff.—This spe-



cies is a specialist on early instar larvae of *Hemiceras* and *Rosema* (Notodontidae) feeding on *Inga* (Fabaceae). It has not been found on any of the tens of species of other caterpillars feeding on *Inga* in the same dry forest.

## TAXONOMY

### *Euplectrus anae* Schauff, new species (Figs. 34, 40–42)

*Diagnosis*.—Face below and between toruli yellow, not extending to eye or past gena (Fig. 13); legs yellow; one pair of setae ss2 between lateral ocelli (as in Fig. 70); all setae S1–6 present (see Fig. 23); longitudinal carina on mesoscutum nearly complete, midlobe without small setae; scutellum finely reticulate; propodeum laterad of median carina nearly smooth; petiole wider than long.

This species is similar to *E. magdae* which also has all the major setae on the face present. It can be differentiated by the petiole being longer than wide whereas related species all have the petiole as wide as long or wider than long.

*Description*.—Female. Body length 2.25mm. Color: body mostly black except the following: face below and between toruli yellow, not extending to eye or past gena; antenna with scape white to light yellow, flagellum yellow; mandibles white; legs yellow; dorsal metasoma with large central yellow area extending from just behind petiole posteriorly for about 2/3 length, becoming darker in posterior 1/4, laterally dark brown; ventral metasoma yellow. *Head*. Dorsally with one pair of minor seta ss2 between posterior ocelli (as in Fig. 70) inserted near occipital carina; seta S5 reduced, setal row sr2 present as 2–3 irregular rows of 10–15 setae reaching the bottom of the eye; occipital carina present medially; width of eye: width of face 12:35; posterior margin of eye separated from margin of head ventrally. Ratio of MS:EH 15:29; lateral ocellus more than 1 diameter from eye (OD:OOD 12:10).

Face below eyes rounded, not abruptly narrowing. Vertex under anterior ocellus reticulate to alutaceous. Toruli separated by about 2–2.5× their own diameters. Malar suture absent. Area under eye irregularly reticulate to alutaceous. Scape 4× as long as wide. Ratio of funicular segments 12:11:11:11:16, width 6 at F1 to 7 at club, each flagellar segment with scattered semierect brown setae, not arranged as whorls basally. *Mesosoma*. Pronotum anterior to transverse carina with scattered setae, finely rugosely reticulate, posterior to carina more openly reticulate and shiny. Mesoscutum (Fig. 42) rugosely reticulate in anterior 1/2, becoming more open, smooth, and shiny posteriorly. Midlobe with median carina fading in anterior 1/4 otherwise complete, slightly sunken posteriorly, posterior setae even with surface, with no small setae antero-laterally. Dorsal axillar/scutellar margin with broad, nearly straight deep furrow with flat bottom. Axillae shiny, openly reticulate, becoming smooth at posterior margin. Scutellum finely reticulate and shiny medially to more finely and striate reticulate laterally, pointed at anterior margin with axillae. Metanotum bordered anteriorly and medially by small alveoli, medially expanded into a triangular flange (Fig. 40) with submedian carinae below. Propodeum laterad of median carina sunken and irregularly carinate alveolate, becoming nearly smooth laterally to the step-like plica, median carina with anterior cup-like flange rounded and deeply invaginated. Area around spiracle finely reticulate, lateral edge of spiracle raised above surface, with antero-lateral flange large and well defined, with 6–8 setae laterad and below spiracle. Posterior margin of propodeum with irregular alveolae and carinae. Petiole in dorsal view wider than long (15:10) and rugose dorsally becoming smooth at posterior margin. *Metasoma*. Ovate, about 1.5× as long as wide, with continuous brown margin laterally. Legs. Ratio of hind tibial spur 1:spur 2:tarsus 1:

T2:T3:T4. 35:23:22:10:8:20. Forewing. Hyaline, about  $2.1\times$  as long as wide. Costal cell with 2 irregular rows of setae ventrally. Venation yellow, ratio of postmarginal: stigmal 35:20.

*Male*.—Similar to female except: body length 1.8 mm; face below toruli lighter yellow, almost white; legs yellow or white; dorsal metasoma with large central white spot, dark brown posteriorly; antenna with scape white slightly swollen on ventral surface, with sensory area slightly darker and with several irregular rows of sensillae extending for about  $3/4$  length (Figs. 34, 41); funicle ratios 11:10:10:10:15, width about 6 anteriorly to 7 posteriorly, with numerous semi-erect brown setae on each flagellomere.

*Hosts*.—*Sphacelodes vulneria* (Geometridae)

*Distribution*.—Known only from the ACG.

*Types*.—Holotype female on point: Costa Rica, Guanacaste Prov., Area de Conservación Guanacaste, Lambert N309450 E355300, 10 m., V. 11, 1992, 92-SRNP-747, D.H. Janzen & W. Hallwachs. ex. *Sphacelodes vulneraria* (Geometridae), (deposited in INBIO). Paratypes: 3 females and 2 males with the same data as holotype (deposited in USNM).

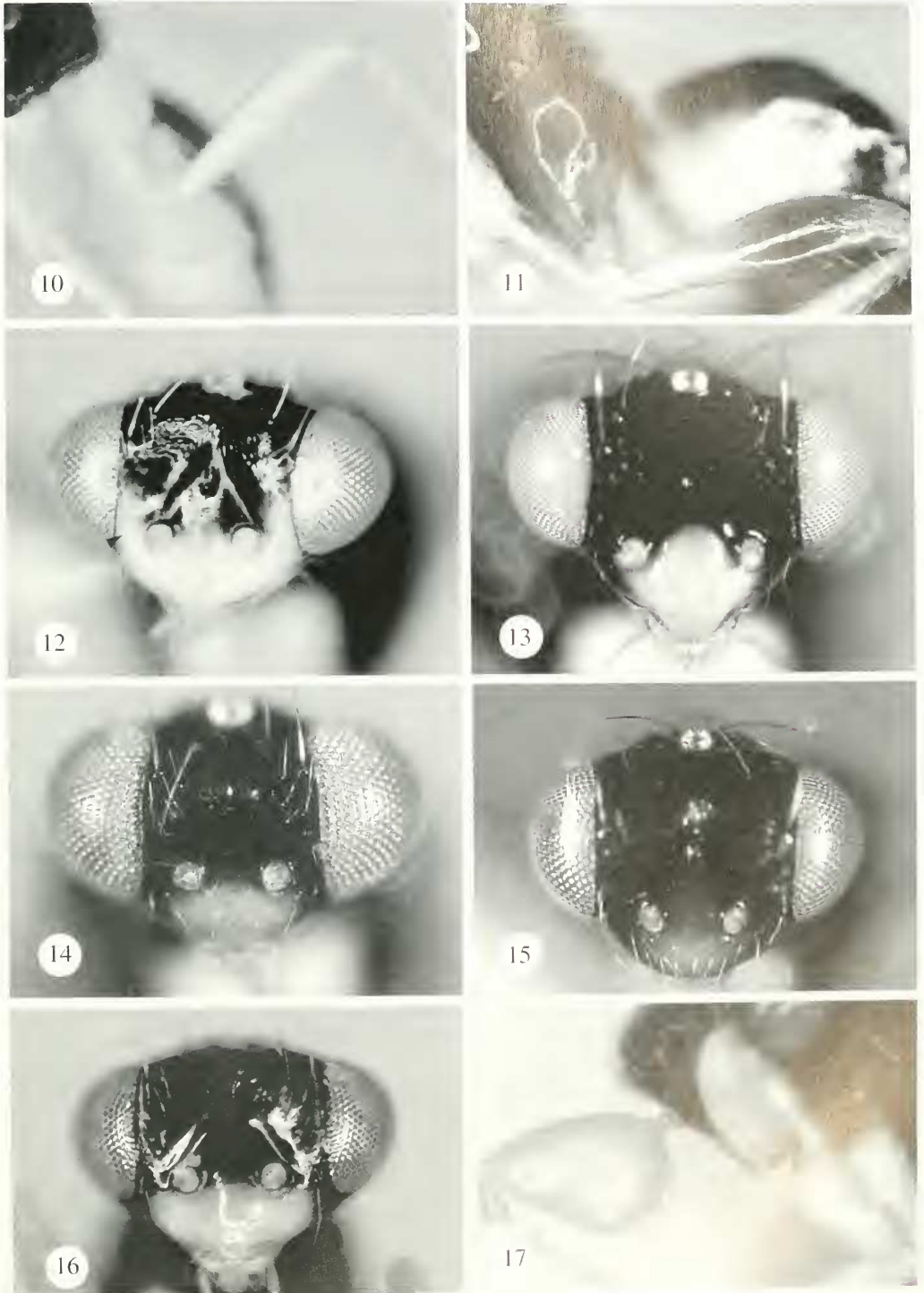
*Etymology*.—This species is named in honor of Ana Leticia Martínez Eras in special recognition of her dedicated attention to the Accounting Office for the Area de Conservación, Guanacaste.

*Euplectrus carlowae* Schauff, new species  
(Figs. 25, 43)

*Diagnosis*.—Face under toruli black; all legs, including hind coxae, yellow; first funicle about same length as antennal club (Fig. 25); posterior margin of scutellum extended over anterior margin of metanotum laterally, anterior edge of metanotum medially expanded outward and divided into two areolae; hind basitarsus about equal in length to second tarsomere. *Eu-*

*plectrus carlowae* is unusual in having the hind basitarsus nearly equal in length to the second tarsus, while in all other species examined the first tarsomere is much longer than the second. It is also somewhat unusual in having a dark face and all yellow legs (although this is shared with *E. edithae*). Other species treated here with the face dark brown or black have at least the hind coxa darkened (*valverdei*, *zamora*, *xiomarae*). The lateral expansion of the scutellum over the anterior edge of the metanotum is also distinctive.

*Description*.—Female. Body length 2.2 mm. Color: body mostly black except the following: antenna with scape yellow to brown, flagellum light brown becoming darker brown apically; mandibles light brown; enlarged setae on vertex dark brown to black; legs yellow; dorsal metasoma dark brown to black behind petiole with yellow inverted T-shaped spot medially, posterior half dark brown, ventral metasoma dark brown behind petiole, then yellow up to about midpoint, then dark brown. *Head*. Dorsally with 2 minor seta ss2 between posterior ocelli, all setae S1–6 present, setal row sr2 present as 2 irregular rows of about 10 setae reaching to bottom of eye; occipital carina weak medially; width of eye: width of face (30:13), posterior margin of eye not nearly contiguous with posterior margin of head over most of length. Ratio of MS:EH 17:29; lateral ocellus more than 1 diameter from eye (OD:OOD 7:8). Face below eyes rounded, not abruptly narrowing. Vertex under anterior ocellus reticulate. Toruli separated by about  $2\times$  their own diameters. Malar suture absent. Area under eye lightly reticulate. Scape  $5.5\times$  as long as wide. Ratio of funicular segments 18:17:15:13:18, width 5 at F1 to 6 at club, flagellar segments with small whorls of brown setae basally. *Mesosoma*. Pronotum anterior to transverse carina with scattered setae, finely rugosely reticulate, posterior to carina reticulate and shiny. Mesoscutum (Fig. 43) reticulate, becoming more open,



Figs. 10-17. *Euplectrus*. 10-11, Hindlegs. 10, *E. floryae*. 11, *E. xiomarae*. 12-16, Dorsal view. 12, *E. floryae*. 13, *E. walleri*. 14, *E. irenae*. 15, *E. orias*. 16, *E. ivonae*. 17, Male scape, *E. calyciflori*.



smooth, and shiny posteriorly. Midlobe with median carina fading in anterior 1/4, not noticeably sunken posteriorly, with no small setae antero-laterally, posterior setae even with surface. Dorsal axillar/scutellar margin with broad, distinctly curved deep furrow with flat bottom. Axillae openly reticulate. Scutellum reticulate to alutaceous, smooth along posterior margin, posterior margin extended over anterior margin of metanotum laterally. Metanotum laterally covered by scutellum, medially with two distinct protruding alveoli, below shiny and smooth to lightly reticulate. Propodeum laterad of median carina shiny and smooth to the step-like plica with occasional faint hints of reticulation, median carina distinctly raised above surface, with large, rounded anterior cuplike flange. Area around spiracle reticulate, spiracle slightly raised and even with surface, with antero-lateral flange present, with 7 setae laterad and below spiracle. Petiole in dorsal view as long as wide (12:11), rugose dorsally. *Metasoma*. Ovate, about 2× as long as wide. Legs. Ratio of hind tibial spur 1:spur 2:tarsus 1:T2:T3:T4. 38:22:17:17:12:18. Forewing. Hyaline, about 2.4× as long as wide. Costal cell with 1 irregular row of setae ventrally. Venation yellowish, ratio of postmarginal:stigmatal 31:16.

*Male*.—Unknown.

*Hosts*.—Unknown.

*Distribution*.—Known only from Puntarenas and Alajuela.

*Types*.—Holotype female on point (antenna and wing slide-mounted) with data: "Costa Rica, Puntarenas, R. F. Golfo Dulce, 24 Km. W. Piedras Blancas, 200 m., IV-V 1992. P. Hanson." (deposited in INBIO). Paratypes: 2 females with same data as holotype except II-III. 1989, 2 females XII. 1989-III. 1990, and 2 females at 100m, III-V. 1989; 1 female Costa Rica: Alajuela, 5km W. San Ramon, 1200m, I. 1997, O. Castro & P. Hanson (deposited in USNM, BMNH).

*Etymology*.—This species, collected only

from Malaise trapping, is named for Ms. Tami Carlow of the Systematic Entomology Lab, USDA who was responsible for most of the scanning electron micrographs used in this paper and also assisted with specimen mounting, labelling and a variety of other tasks vital to the completion of this work.

### *Euplectrus comstockii* Howard

(Figs. 27, 44)

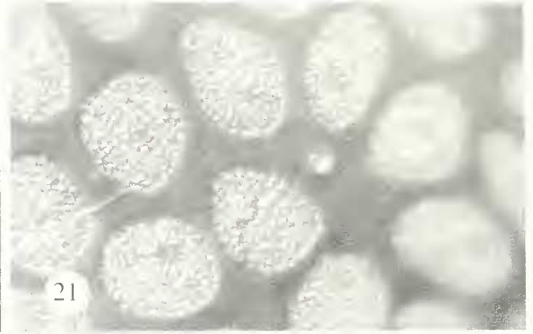
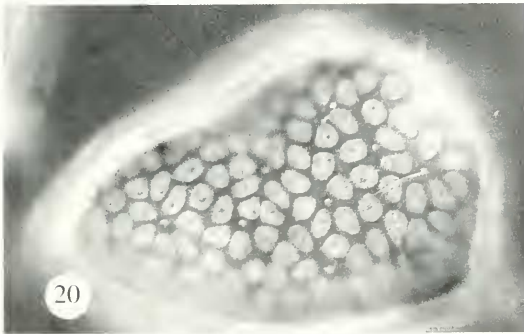
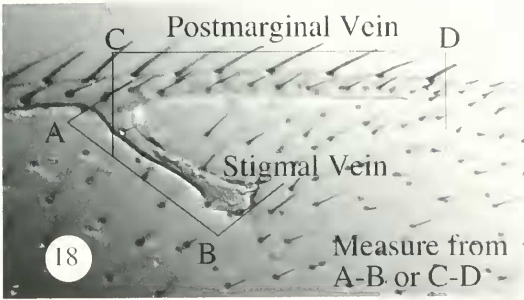
*Euplectrus comstockii* Howard 1880:158.

*Diagnosis*.—Legs yellow; face under toruli yellow; first funicle 2× as long as wide; seta 5 present (see Fig. 23), but reduced; with one pair of small setae (ss2) between posterior ocelli (as in Fig. 66); F1 2× as long as wide; median longitudinal mesoscutal carina nearly complete; scutellum lightly reticulate and shiny medially, becoming striate laterally; anterior metanotum with large, obvious line of alveoli (Fig. 44), central transverse band narrow, smooth; propodeum adjacent to median carina lightly reticulate, shiny. Petiole wider than long. *Metasoma* mostly yellow, becoming brown posteriorly. Male scape slightly (Fig. 27) expanded near apex, with 2 irregular short rows of sensillae.

*E. comstockii* is most similar to *solitarius* but can be separated by the petiole which is longer than wide in *solitarius* and wider than long in *comstockii* and the antennae which has F1 2× as long as wide in *comstockii* and 3× as long as wide in *solitarius*.

*Distribution*.—Widespread in United States, Central and South America.

*Hosts*.—The following records are primarily drawn from the literature (Burks 1979, Noyes 1998). In a few instances they have been verified from specimen label data in collections (USNM, CNC). It is our opinion, based on data from the species reared in this study, that at least some of these records probably represent misidentifications of either the parasite or the host. *Alypia octomaculata*; *Anomis illita*; *Autogra-*



Figs. 18–22. *Euplectrus*. 18, Forewing venation. 19, *E. xiomarac*, male scape, 20–21, *E. valverdei*, male scape. 22, *E. zamorai*, head and antennae.

*pha* sp.; *Caradrina* sp.; *Hadena luteago*; *Helicoverpa armigera*; *Helicoverpa zea*; *Heliiothis* sp.; *Heliiothis virescens*; *Hypeua scabra*; *Leucaenia latiuscula*; *Neogalea sunia*; *Plusia* sp; *Pseudoplusia includens*; *Seleuisa sueroides*; *Spodoptera frugiperda*; *Spodoptera ornithogalli*; *Trichoplusia ni* (Noctuidae); *Fernandella finetaria* (Geometridae); *Rottschilda aroma* (Saturniidae).

*Types*.—Howard described this species from “two male specimens”. He indicated that the original specimens had been collected by Comstock and that “upon looking them up, I found that two adults had

issued”. In the U.S. National Museum collection, there is a series containing both males and females, on cards and points and all bearing the USNM type no. 2653. The type catalog entry for this species lists both male and female specimens collected in 1878 and 1880 by W.H. Patton and S. A. Schwarz (not Comstock) and the number of specimens listed is “many”. Howard made no mention of localities in his original description, but all the USNM specimens with locality labels are from Selma, Alabama, collected in 1880, except one collected in 1878 from Florida. Ac-

cording to the description, the types were reared in 1879 during fieldwork conducted by Comstock. None of the points or cards contains only 2 males. Given these facts, we believe it likely that none of the specimens labelled as types in the USNM collection are in fact the specimens that Howard used for his original description, but rather the specimens currently labelled as types are specimens used by him for a subsequent redescription (Howard 1885). Since the original type specimens are lost, we are erecting a neotype (present designation). This specimen is one of the series labelled as types. It is a female on a card with 3 other specimens and has been marked with an "N" in black ink. The label data is: "Selma, Oct., 81. Patton. Type no. 2653, U.S.N.M."

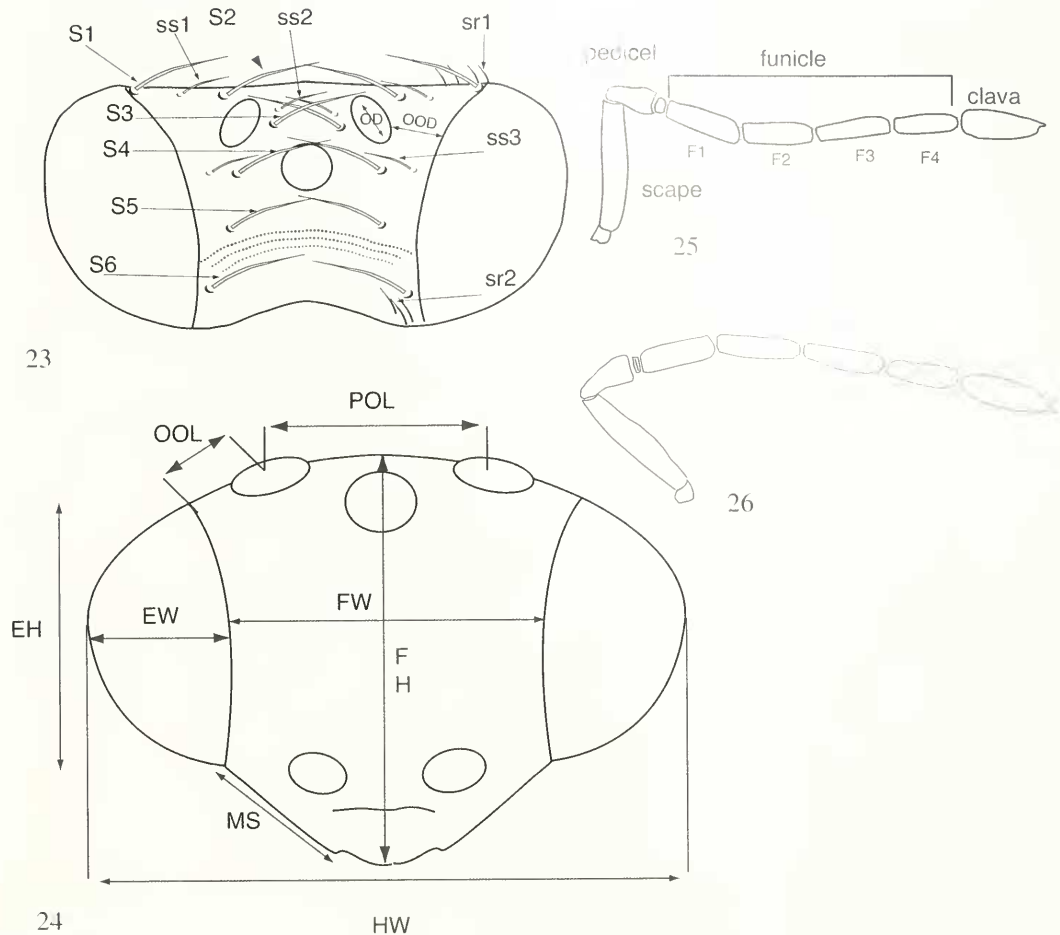
*Euplectrus edithae* Schauff, new species  
(Fig. 39)

*Diagnosis*.—Face black below toruli (as in Fig. 15), legs yellow; one pair of setae ss2 between lateral ocelli; flagellum brown, funiculars about 2× as long as wide; malar space nearly equal to eye height; petiole as wide as long; postmarginal less than 1.5× stigmal. This combination of a black face below the toruli and yellow hind coxae is found only in this species and in *E. carlowae*. In addition, *E. carlowae* has the second tarsomere of the hind leg nearly equal in length to the first (second tarsomere much shorter than first in *edithae*) and the lateral scutellum is expanded and overlaps the metanotum (lateral scutellum not overlapping metanotum in *edithae*).

*Description*.—Female. Body length 2.2–2.3 mm. Color: body mostly black except the following: antenna with scape yellow to brown, flagellum brown; mandibles yellow; enlarged setae on vertex yellow to dark brown; legs yellow; dorsal metasoma dark yellow behind petiole and ventrally, dark brown laterally. *Head*. Dorsally with 2 minor seta ss2 between posterior ocelli, seta S5 reduced, setal row sr2 present as 2

irregular rows of about 8 setae reaching to bottom of eye; occipital carina reduced; width of eye: width of face (40:13), posterior margin of eye not nearly contiguous with posterior margin of head over most of length. Ratio of MS:EH 19:22; lateral ocellus more than 1 diameter from eye (OD:OOD 5:10). Face below eyes abruptly narrowing. Vertex under anterior ocellus reticulate. Toruli separated by about 2× their own diameters. Malar suture absent. Area under eye lightly reticulate. Scape 6× as long as wide. Ratio of funicular segments 11:11:11:11:16, width 5 at F1 to 6 at club, flagellar segments with small whorls of brown setae basally. *Mesosoma*. Pronotum anterior to transverse carina with scattered setae, finely rugosely reticulate, posterior to carina reticulate and shiny. Mesoscutum reticulate, becoming more open, smooth, and shiny posteriorly. Mid-lobe with median carina complete, not noticeably sunken posteriorly, with no small setae antero-laterally, posterior setae even with surface. Dorsal axillar/scutellar margin with relatively narrow, parallel sided furrow making anterior margin of scutellum distinctly V-shaped. Axillae openly reticulate. Scutellum reticulate to alutaceous, smooth along posterior margin, posterior margin not extended over anterior margin of metanotum laterally. Metanotum with a line of alveoli anteriorly. Propodeum laterad of median carina lightly reticulate, shiny and smooth to the step-like plica, median carina distinctly raised above surface, with large anterior cup-like flange which is somewhat truncated posteriorly. Area around spiracle reticulate, spiracle slightly raised and even with surface, with antero-lateral flange present, with 10–12 setae laterad and below spiracle. Petiole in dorsal view as long as wide (10:10), rugose dorsally. *Metasoma*. Ovate, about 1.5× as long as wide. Legs. Ratio of hind tibial spur 1:spur 2:tarsus 1: T2:T3:T4. 37:25:25:13:10:13. Forewing. Hyaline, about 2.5× as long as wide. Costal cell with 2 irregular rows of setae ventral-





Figs. 23-26. *Euplectrus* morphology. 23, Head in dorsal view. 24, Head in frontal view. 25, Female antenna of *E. carlowae*. 26, Female antenna of *E. hansonii*. EW = eye width. EH = Eye height. FW = Face width. FH = Face height. HW = Head width. MS = Malar space. OOD = Ocell-ocular distance. OOL = Ocell-ocular length. POL = Posterior ocellar length. S1-6 = Major setae 1 to 6. sr = setal row. ss = small setae. OD = ocellar diameter.

ly. Venation yellowish, ratio of postmarginal: stigmal 32:25.

*Male*.—Similar to female except: scape yellow to white and slightly swollen apically (Fig. 39) with two irregular rows of sensillae running about 2/3 length; legs generally yellow; metasoma darker, nearly black in posterior half both dorsally and ventrally; funicle ratio 11:11:11:10:15, width 4-6 with no noticeable brown setae.

Since the male of this species was not reared with the associated females, I cannot be absolutely positive of the relation-

ship. However, all the specimens were collected at the same locality at the same time and although other species were also present in those collections, this male matches the females of this species much more closely, and we are sufficiently confident of the association to assign it to this species.

*Hosts*.—Unknown

*Distribution*.—Costa Rica.

*Types*.—Holotype female with data: "Costa Rica, San Jose, Zurqui de Moravia, 1600m, IV.1995, P. Hanson", (deposited in

INBIO). Paratypes: 10 females and 1 male with same data except 2 collected in January 1996 (deposited in USNM and BMNH).

*Etymology.*—This species is named in honor of Edith López Lara in special recognition of her dedicated attention to the Research Center and Dormitories in Sector Santa Rosa of the Area de Conservación Guanacaste.

*Euplectrus floryae* Schauff, new species  
(Figs. 10, 12, 28, 45–48)

*Diagnosis.*—Face below and between toruli yellow, extending up side of eye to midpoint and around face to gena and mouth (Fig. 12); two pairs of small setae (ss2) between lateral ocelli (Fig. 66); mesoscutal midlobe with 1–2 small setae anteriorly (Fig. 48), median carina complete; scutellum heavily reticulate to alutaceous; petiole in dorsal view as long as wide and rugose dorsally with irregular longitudinal carina. Male antennal scape white, slightly swollen, with narrowly ovate sensory area containing 2–3 irregular rows of sensillae extending about 3/4 length (Fig. 28), F1 slightly shorter than club.

The coloration of the face with yellow running up the side of the eyes makes this species quite distinctive among Costa Rican species. In addition, two pairs of small setae between the lateral ocelli and small setae on the anterior mesoscutal midlobe distinguish it from similar species treated here. This species is similar to *Euplectrus maculiventris* Westwood which is widespread in Canada and the U.S. and which may occur in Central America. *E. maculiventris* has the face yellow with the yellow extending up the side of the eyes. However, *E. maculiventris* has the median carina on the scutum nearly absent and the antenna of the male has the scape more enlarged and with 5–6 rows of sensillae, and the funicles are elongate and each is covered by elongate setae.

*Description.*—Female. Body length 2.1–2.3 mm. Color: body mostly black except

the following: face below and between toruli yellow, extending laterad of toruli over gena, down to mouth, and up edge of eye to near midpoint (Fig. 12); antenna with scape white to light yellow, flagellum yellow or light brown; mandibles yellow to white; legs light yellow to white; dorsal metasoma with large central yellow to white area extending from just behind petiole posteriorly over entire length of dorsum, becoming slightly darker posteriorly, lateral brown margin reduced to two brown spots separated medially by yellow and ending well before posterior margin, ventral metasoma yellow to white. *Head.* Dorsally with two pair of minor setae ss2 between posterior ocelli (as in Fig. 46), inserted adjacent to occipital carina, setae S1–6 present (as in Fig. 23), setal row sr2 present as 1–2 irregular rows of 12–16 setae, reaching the bottom of the eye. Occipital carina strongly present over entire length of occiput. Width of eye: width of face 13:35, posterior margin of eye nearly contiguous with posterior margin of head of most of length. Ratio of MS:EH 17:31, lateral ocellus more than 1 diameter from eye (OD:OOD 6:8). Face below eyes rounded, not abruptly narrowing. Vertex below anterior ocellus reticulate to alutaceous. Toruli separated by about 2–2.2× their own diameters. Malar suture absent. Area under eye lightly reticulate to smooth (difficult to assess because of yellow coloration). Scape 5× as long as wide. Ratio of funicular segments 14:12:12:13:17, width 5 at F1 to 6 at club, flagellar segments with small indistinct whorls of brown setae basally. *Mesosoma.* Pronotum anterior to transverse carina with scattered setae, finely rugosely reticulate, posterior to carina more openly reticulate and shiny. Mesoscutum (Fig. 48) reticulate, becoming more smooth, and shiny posteriorly. Midlobe with median carina well defined, fading only at extreme anterior margin, otherwise complete, slightly sunken posteriorly, with one or two small setae antero-laterally, posterior setae even with

surface or slightly raised. Dorsal axillar/scutellar margin with broad, curved deep furrow with flat bottom. Axillae shiny, openly reticulate. Scutellum shiny and lightly reticulate to alutaceous. Metanotum bordered anteriorly by a narrow band of small alveoli, medially shiny and lightly reticulate. Propodeum laterad of median carina shiny and openly reticulate to the step-like plica, median carina with anterior cup-like flange rounded and invaginated. Area around spiracle finely reticulate or granulate, spiracle slightly raised above surface (Fig. 47), opening parallel to the surface of the propodeum, with antero-lateral flange large and obvious, with 10–12 setae laterad and below spiracle. Petiole in dorsal view as long as wide (10:10), rugose dorsally with irregular longitudinal carina. *Metasoma*. Ovate, about 1.5–2× as long as wide. Legs. Ratio of hind tibial spur 1:spur 2:tarsus 1:T2:T3:T4. 35:25:23:13:10:13. Forewing. Hyaline, about 2.5× as long as wide. Costal cell with 2–3 irregular rows of setae ventrally. Venation yellow to white, ratio of post-marginal: stigmal (28:18).

*Male*.—Similar to female except: body length 1.8–2mm; face white, legs white to light yellow, metasoma with central white spot only extending about 1/2 to 2/3 of length, dark brown posteriorly, laterally dark brown, sometimes interrupted medially; antenna with scape white (Fig. 45), slightly swollen, with narrowly ovate sensory area containing 2–3 irregular rows of sensillae extending about 3/4 length (Fig. 28); funicle ratios 13:12:14:12:15, width 5, without scattered or whorled semierect brown setae on each flagellomere.

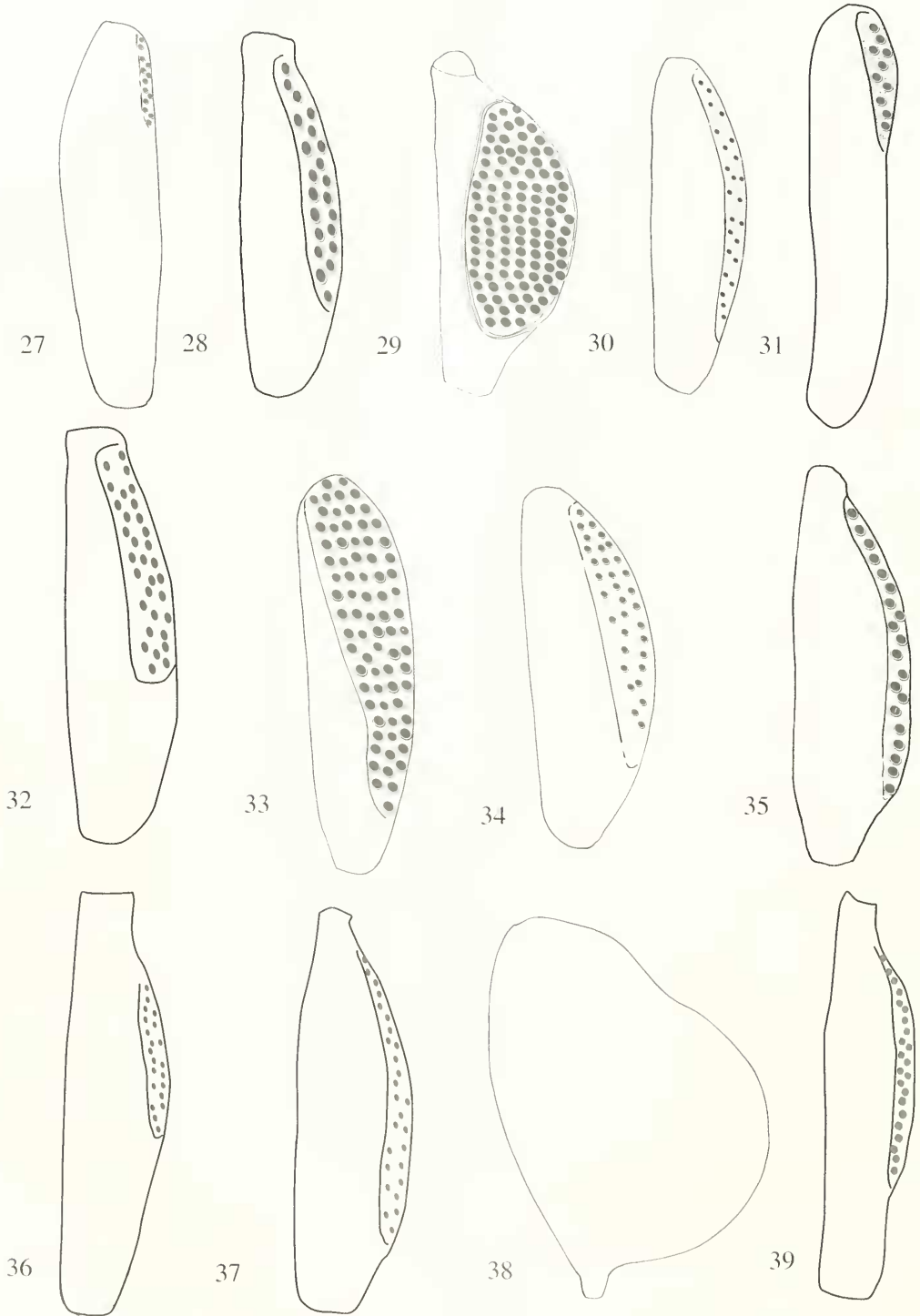
*Hosts*.—*Enyo ocypte*, *Perigonia ilus*, *P. lusca*, *Aellopos fasus* (all Sphingidae).

*Distribution*.—Known only from the ACG.

*Etymology*.—This species is named in honor of Flory Granados Venegas in special recognition of her dedicated management of the main Administrative Office of the Area de Conservación Guanacaste.

*Types*.—Holotype female: "Costa Rica, Guanacaste Prov., Area de Conservación Guanacaste, Lambert N320050 E365300, 160m., III. 5, 1992, 92-SRNP-524, D. H. Janzen & W. Hallwachs. ex. *Enyo ocypte*" (deposited in INBIO). Paratypes: 3 females and 1 male all with the same data as holotype; other specimens from the ACG: 2 males with Lambert N317200 E360850, 290m., V. 3, 1994, 94-SRNP-918; 2 males with Lambert N325500 E360200, 270m., VI. 14, 1990, 90-SRNP-112; 2 females and 1 male with Lambert N313800 E359800, 300m., VIII. 4, 1993, 93-SRNP-4177, ex. *Perigonia ilus*; 1 female and 1 male with Lambert N319000 E361150, 270m., X. 11, 1992, 92-SRNP-5353; 1 female with Lambert N319500 E360650, 260m., VI. 8, 1992, 92-SRNP-1115; 1 male and 1 female with Lambert N314500 E357850, 290m., VII. 27, 1990, 90-SRNP-1522; 1 female with Lambert N314500 E357850, 290m., VI. 8, 1992, 92-SRNP-1084; 1 male with Lambert N319550 E360650, 290m., VI. 10, 1992, 92-SRNP-1112; 2 females with Lambert N314500 E357850, 290m., VIII. 5, 1992, 92-SRNP-3929; 1 male with Lambert N319100 E360900, 260m., V. 25, 1992, 92-SRNP-831; 1 female with Lambert N314500 E357850, 240m., VII. 21, 1993, 93-SRNP-2502, ex. *Perigonia lusca*; 1 male with Lambert N315700 E354400, 300m., VI. 6, 1992, 92-SRNP-1009; 1 female with Lambert N315500 E360200, 300m., VII. 23, 1991, 91-SRNP-1792, ex. *Perigonia ilus*; 1 male with Lambert N319000 E361150, 270m., II. 2, 1992, 92-SRNP-293, ex. *Aellopos fadus*; 1 female with Lambert N314800 E360500, 300m., VII. 23, 1984, 84-SRNP-1479; 1 male and 1 female with Lambert N314650 E361300, 270m., XI. 20, 1993, 93-SRNP-7708 ex. *Perigonia ilus*; 3 males with Lambert N313100 E359900, 250m., VIII. 24, 1990, 90-SRNP-1946; 1 female with Lambert N319100 E360900, 260m., VII. 13, 1992, 92-SRNP-2642; 1 female with Lambert N312300 E360950, 260m., VI. 12, 1992, 92-SRNP-1073; 1 female with Lambert N314500 E357850, 290m., V. 26, 1991, 91-





Figs. 27-39. *Euplectrus* male scapes. 27, *E. comstockii*. 28, *E. floryae*. 29, *E. walteri*. 30, *E. mariaae*. 31, *E. romici*. 32, *E. ivonae*. 33, *E. magdae*. 34, *E. anaee*. 35, *E. josei*. 36, *E. xiomarae*. 37, *E. orias*. 38, *E. valverdei*. 39, *E. edithae*.

SRNP-328; 2 males with Lambert N319000 E361150, 270m., V. 10. 1994, 94-SRNP-935; 1 female with Lambert N313800 E359800, 300m., VI. 19. 1988, 88-SRNP-229, ex. *Perigonia ilus*; 1 female with Lambert N314800 E360500, 300m., VIII. 12. 1991, 91-SRNP-2479, ex. *Perigonia ilus*; 2 males with Lambert N314500 E357850, 290m., V. 28. 1991, 91-SRNP-248; 1 female with Lambert N313100 E359900, 250m., VII. 4. 1982, 82-SRNP-368, ex. *Perigonia ilus*; 1 female with Lambert N313800 E359800, 300m., VII. 28. 1984, 84-SRNP-1501 ex. *Cautethia spuria*; 1 male with Lambert N315500 E360200, 300m., VII. 15. 1991, 91-SRNP-1512, ex. *Perigonia ilus*; 1 female with Lambert N314800 E360500, 300m., VIII. 13. 1992, 92-SRNP-3473; 1 female with Lambert N317200 E360850, 290m., V. 28. 1991, 91-SRNP-280; 1 female with Lambert N317200 E360850, 290m., V. 27. 1991, 91-SRNP-278; 1 female with Lambert N317200 E360850, 290m., V. 27. 1991, 91-SRNP-277 (deposited in USNM, BMNH, and CNC).

### *Euplectrus furnius* Walker

(Figs. 49, 50)

*Euplectrus furnius* Walker 1843:48.

*Pachyscapa insularis* Howard 1897:159. (Synonymy by Bouček 1977; see also Bouček in Desantis 1979).

**Diagnosis.**—Apical flagellar segments generally darker than F1 (as in Fig. 22); legs yellow; face below toruli dark brown to black; with no small setae between posterior ocelli (Fig. 49); width of face nearly 4× width of eye; posterior ocellus 2× its diameter from eye margin; scutellum nearly smooth, shiny, with some light reticulation; petiole wider than long; postmarginal vein barely longer than stigmal (25:20). Male antenna with scape dark brown, greatly enlarged (Fig. 50), and uniformly covered with sensillae, with funicular segments quadrate and F3 and 4 dark brown contrasting with F1 and 2 which are yellow.

*Euplectrus furnius* is a distinctive species easily recognized by the dark, broad face, with ocelli 2 diameters removed from the eye, gradually darkening antennal flagellum in the female (even more marked in the males) and short postmarginal vein. The dark, greatly swollen scape of the male is also quite distinctive. Although other species of *Euplectrus* are known to have similar scapes, none of those treated in this study have a swollen scape that is also dark colored.

**Hosts.**—The following records are primarily drawn from the literature (Burks 1979, Noyes 1998). In a few instances they have been verified from specimen label data in collections (USNM, CNC). Hosts include *Agrius cingulatus* (Sphingidae); *Antichloris eriphia* (Arctiidae); *Hadena luteago*; *Helicoverpa zea*; *Lamprosema indicata*; *Pseudoplusia includens*; *Rachisplusia nu*; *Spodoptera eridania*; *S. frugiperda* (Noctuidae).

**Distribution.**—Known from Mexico south to Ecuador and Venezuela and west to the West Indies.

**Types.**—The lectotype of *E. furnius* is in The Natural History Museum London (examined). Lectotype and paralectotypes of *E. insularis* are in the USNM (examined).

### *Euplectrus hansonii* Schauff, new species (Fig. 26)

**Diagnosis.**—Face yellow below toruli (as in Fig. 13), legs yellow; one pair of setae ss2 between lateral ocelli; F1–4 all about 3× as long as wide and nearly equal to club (Fig. 26), flagellum dark brown; postmarginal more than 2× stigmal (see Fig. 18).

This species is most easily distinguished by the elongate and dark brown funicle segments (F1–4 about 3× as long as wide and F1–3 nearly as long as club). In *E. walteri* in which F1 is also almost as long as the club, the funiculars are only about 2× as long as wide and the segments are yellow or light brown colored. In addition, the long postmarginal vein (more than 2× as long as the stigmal) is longer than in

the other species where it is usually  $2\times$  as long as the stigmal or less.

*Description.*—Female. Body length 2.2–2.6 mm. Color: body mostly black except the following: antenna with scape yellow to brown, flagellum dark brown; mandibles yellow; enlarged setae on vertex yellow to dark brown; legs yellow; dorsal metasoma dark brown to black behind petiole with yellow spot medially, posterior half dark brown, ventral metasoma dark brown behind petiole, then yellow up to about midpoint, then dark brown. *Head.* Dorsally with 2 minor seta ss2 between posterior ocelli (as in Fig. 23), all setae S1–6 present, setal row sr2 present as 2 irregular rows of about 8 setae reaching to bottom of eye; occipital carina obvious medially; width of eye: width of face (36:13), posterior margin eye of not nearly contiguous with posterior margin of head over most of length. Ratio of MS:EH 18:30; lateral ocellus more than 1 diameter from eye (OD:OOD 6:9). Face below eyes rounded, not abruptly narrowing. Vertex under anterior ocellus reticulate. Toruli separated by about  $2\times$  their own diameters. Malar suture absent. Area under eye lightly reticulate. Scape  $5\times$  as long as wide. Ratio of funicular segments 19:19:19:17:21, width 6 at F1 to 7 at club, flagellar segments with small whorls of brown setae basally. *Mesosoma.* Pronotum anterior to transverse carina with scattered setae, finely rugosely reticulate, posterior to carina reticulate and shiny. Mesoscutum reticulate, becoming more open, smooth, and shiny posteriorly. Midlobe with median carina fading in anterior  $1/4$ , not noticeably sunken posteriorly, with no small setae antero-laterally, posterior setae even with surface. Dorsal axillar/scutellar margin with broad, distinctly curved deep furrow with flat bottom. Axillae openly reticulate. Scutellum reticulate to alutaceous, smooth along posterior margin, posterior margin not extended over anterior margin of metanotum laterally. Metanotum with a very thin line of alveoli anteriorly. Pro-

podeum laterad of median carina lightly reticulate, shiny and smooth to the step-like plica, median carina distinctly raised above surface, with large anterior cup-like flange which is somewhat truncated posteriorly. Area around spiracle reticulate, spiracle slightly raised and even with surface, with antero-lateral flange present, with 6–7 setae laterad and below spiracle. Petiole in dorsal view longer than wide (14:10), rugose dorsally. *Metasoma.* Ovate, about  $1.5\times$  as long as wide. Legs. Ratio of hind tibial spur 1:spur 2:tarsus 1:T2:T3:T4. 40:25:22:17:12:16. Forewing. Hyaline, about  $2.4\times$  as long as wide. Costal cell with 2 irregular rows of setae ventrally. Venation yellowish, ratio of postmarginal:stigmal (50:23).

*Male.*—Unknown.

*Hosts.*—Unknown.

*Distribution.*—Known only from the type locality.

*Types.*—Holotype female, deposited in USNM, with data: "Costa Rica, San Jose, Zurqui de Moravia, 1600m, IX.1996, P. Hanson". Paratype female with same data deposited in USNM.

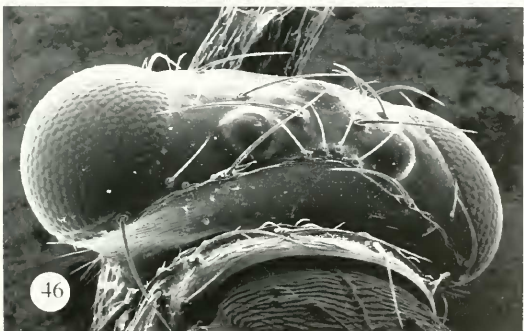
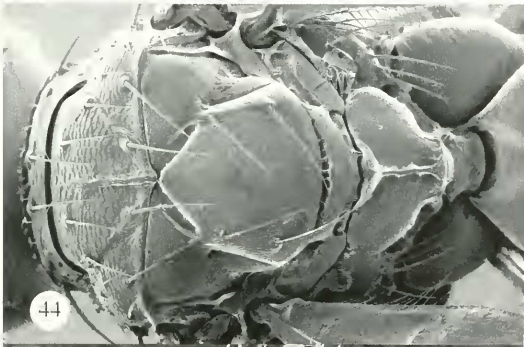
*Etymology.*—This species is named for the collector of the types, Paul Hanson, who also contributed many other interesting specimens to this study.

### *Euplectrus ireneae* Schauff, new species (Figs. 14, 51)

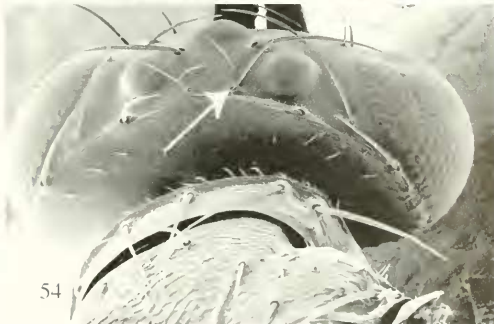
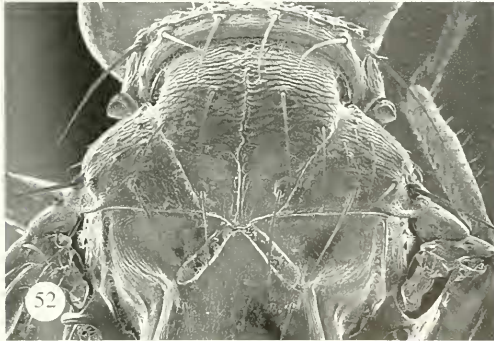
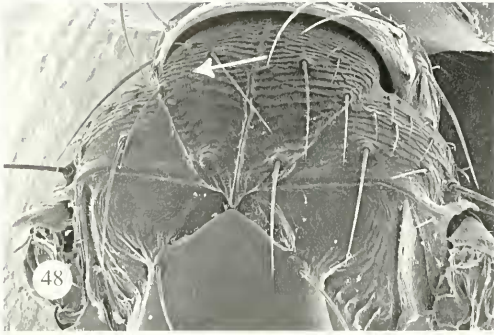
*Diagnosis.*—Face below and between toruli yellowish brown, lighter than above toruli; legs light yellow to white; width of eye more than half width of face (Fig. 14), lateral ocellus less than 1 diameter from eye; with 1 pair of setae (ss2) between lateral ocelli; setal row sr2 present as 1–2 irregular rows of 5–12 setae usually not reaching the bottom of the eye.

The structure of the head with the lateral ocellus less than 1 diameter from the eye and the eye itself more than half the width of the face (frontal view) make this species easily recognizable from all other species treated.





Figs. 40–47. *Euplectrus* scanning electron micrographs. 40–42, *E. anae*. 40, Propodeum. 41, Male antennae. 42, Mesosoma. 43, *E. carlowae*, Scutellum and propodeum. 44, *E. comstockii*, mesosoma. 45–47, *E. floryae*. 45, Male scape. 46, Head, dorsal view. 47, Propodeum.



Figs. 48–55. *Euplectrus* scanning electron micrographs. 48, *E. floryae*, dorsal mesosoma. 49–50, *E. furnius*. 49, Head, dorsal view. 50, Male scape. 51, *E. irenae*, propodeum. 52–53, *E. ivonae*. 52, Dorsal mesosoma. 53, Propodeum. 54–55, *E. josi*. 54, Head, dorsal view. 55, Dorsal mesosoma.



*Description*.—Female. Body length 2.3–2.6 mm. Color: body mostly black except the following: face below and between toruli yellowish brown; antenna with scape white to light yellow, flagellum yellow; mandibles yellow; legs light yellow to white; dorsal metasoma with large central yellow area extending from just behind petiole posteriorly for about 1/2 length, and extending laterally around the side of the metasoma, posteriorly dark brown, ventral metasoma yellow. *Head*. Dorsally with one pair of minor seta ss2 between posterior ocelli (as in Fig. 70), inserted distinctly above occipital carina, all setae S1–6 present, setal row sr2 present as 1–2 irregular rows of 5–12 setae usually not reaching the bottom of the eye; occipital carina present medially; width of eye: width of face 17:30, posterior margin eye of contiguous with posterior margin of head of most of length. Ratio of MS:EH 13:36; lateral ocellus less than 1 diameter from eye (OD:OOD 12:5). Face below eyes rounded, not abruptly narrowing. Vertex under anterior ocellus lightly reticulate. Toruli separated by about 2–2.5× their own diameters. Malar suture absent. Area under eye lightly reticulate. Scape 5× as long as wide. Ratio of funicular segments 16:15:16:16:20, width 6 at F1 to 8 at club. *Mesosoma*. Pronotum anterior to transverse carina with scattered setae, finely rugosely reticulate, posterior to carina more openly reticulate and shiny. Mesoscutum reticulate in anterior 1/2, becoming more smooth, and shiny posteriorly with slight reticulation. Midlobe with median carina fading only at extreme anterior margin, otherwise complete, not sunken posteriorly, with no small setae antero-laterally, posterior setae even with surface. Dorsal axillar/scutellar margin with broad, slightly curved, deep furrow with flat bottom. Axillae shiny, openly reticulate, becoming nearly smooth at posterior margin. Scutellum finely reticulate to alutaceous, shiny, slightly pointed at anterior margin with axillae. Metanotum not bor-

dered anteriorly and medially by small alveoli, medially flat and shiny and very lightly reticulate without median carina below. Propodeum laterad of median carina nearly smooth (lightly reticulate) laterally to the step-like plica, median carina with anterior cup-like flange rounded and invaginated. Area around spiracle finely reticulate, lateral edge of spiracle raised above surface (Fig. 51), with antero-lateral flange large and well defined, with 7–8 setae laterad and below spiracle. Posterior margin of propodeum without irregular alveolae and carinae. Petiole in dorsal view slightly wider than long (14:13) and rugose dorsally, becoming smooth at posterior margin. *Metasoma*. Ovate, about 1.5X as long as wide, with brown margin laterally interrupted by yellow about midpoint making the yellow area appear as an inverted “T” shape, ventrally light yellow to white, becoming dark yellow posteriorly. Legs. Ratio of hind tibial spur 1:spur 2:tarsus 1:T2:T3:T4. 35:28:20:17:11:19. Forewing. Hyaline, about 2.2× as long as wide. Costal cell with 1 and occasionally a partial second irregular row of setae ventrally. Venation yellow to white, ratio of postmarginal: stigmal (29:20).

*Male*.—Unknown.

*Hosts*.—*Motyia abseuzalis* (Noctuidae).

*Distribution*.—Known only from the type locality.

*Types*.—Holotype female: Costa Rica, Guanacaste Prov., Area de Conservación Guanacaste, Lambert N309250 E353000, 2m., VII. 6, 1995, 95-SRNP-6049, D.H. Janzen & W. Hallwachs. ex. *Motyia abseuzalis* (deposited in INBIO). Paratypes: 6 females with the same data as holotype (deposited in USNM and BMNH).

*Etymology*.—This species is named in honor of Irene Carrillo Carillo in special recognition of her dedicated attention to the dining operations in Sector Santa Rosa of the Area de Conservación Guanacaste.

*Euplectrus ivonae* Schauff, new species  
(Figs. 16, 32, 52, 53)

*Diagnosis*.—Face below and between toruli yellow, extending laterally to near eye



and ventrally around mouth and gena (Fig. 16); legs yellow; one pair of setae ss2 between lateral ocelli; seta S5 absent; longitudinal carina on mesoscutum nearly complete, midlobe without small setae; scutellum finely longitudinally striate reticulate; metanotum bordered anteriorly and medially by small alveoli, medially expanded into a triangular flange; propodeum laterad of median carina nearly smooth (lightly reticulate) (Fig. 53); dorsal metasoma with large central yellow area extending from just behind petiole posteriorly for about 2/3 length, interrupted posteriorly by a central dark spot and becoming lighter brown again in posterior 1/4, laterally dark brown. Male. Face with white area almost touching eye laterally; legs white; antenna with scape white, slightly swollen on ventral surface, with sensory area slightly darker and with several irregular rows of sensillae extending for about 3/4 length (Fig. 32).

This species is similar to species like *magdae*, *ronniei*, and *mariae*, which lack S5 and have the face yellow. In this species, the face is more extensively yellow with the coloration extending laterad of the toruli over to and below the eyes. It does not, however, extend up the margin of the eyes as in *floryae*.

*Description.*—Female. Body length 2.25–2.5 mm. Color: body mostly black except the following: face below and between toruli yellow, extending laterally to near eye and ventrally around mouth and gena (Fig. 16); antenna with scape white to light yellow, flagellum yellow to light brown; mandibles yellow; legs yellow; dorsal metasoma with large central yellow area extending from just behind petiole posteriorly for about 2/3 length, interrupted posteriorly by a central dark spot and becoming lighter brown again in posterior 1/4, laterally dark brown; ventral metasoma yellow. *Head.* Dorsally with one pair of minor seta ss2 inserted near occipital carina between posterior ocelli (as in Fig. 70), seta S5 absent, setal row sr2 present

as 2–3 irregular rows of 12–18 setae reaching the bottom of the eye; occipital carina present medially; width of eye: width of face 12:38, posterior margin of eye separated from margin of head ventrally. Ratio of MS:EH 18:30; lateral ocellus more than 1 diameter from eye (OD:OOD 13:10). Face below eyes rounded, not abruptly narrowing. Vertex under anterior ocellus reticulate. Toruli separated by about 2× their own diameters. Malar suture absent. Area under eye irregularly reticulate to alutaceous. Scape 6× as long as wide. Ratio of funicular segments 13:13:14:14:18, width 7 at F1 to 8 at F4. *Mesosoma.* Pronotum anterior to transverse carina with scattered setae, finely rugosely reticulate, posterior of carina more openly reticulate and shiny. Mesoscutum (Fig. 52) rugose reticulate in anterior 1/2, becoming more smooth and shiny posteriorly with slight reticulation. Midlobe with median carina fading only at extreme anterior margin, otherwise complete, slightly sunken posteriorly, with no small setae antero-laterally, posterior setae raised above surface on small tubercle. Dorsal axillar/scutellar margin with broad, nearly straight deep furrow with narrow but flat bottom. Axillae shiny, openly reticulate, becoming smooth at posterior margin. Scutellum finely longitudinally striate reticulate, pointed anteriorly at axillar margin. Metanotum bordered anteriorly and medially by small alveoli, medially expanded into a triangular flange (Fig. 53) with median carina below. Propodeum laterad of median carina nearly smooth (lightly reticulate) laterally to the step-like plica, median carina with anterior cup-like flange rounded and deeply invaginated. Area around spiracle finely reticulate, lateral edge of spiracle raised above surface, with antero-lateral flange large and well defined, with 9–10 setae laterad and below spiracle. Posterior margin of propodeum without irregular alveolae and carinae. Petiole in dorsal view wider than long (17:10) and rugose dorsally becoming smooth at pos-

terior margin. *Metasoma*. Ovate, about 1.5× as long as wide, with brown margin laterally interrupted by yellow about mid-point making the yellow area appear as an inverted "T" shape. Legs. Ratio of hind tibial spur 1:spur 2:tarsus 1:T2:T3:T4. 41:30:30:17:7:17. Forewing. Hyaline, about 2.2× as long as wide. Costal cell with 2 irregular rows of setae ventrally. Venation yellow to white, ratio of postmarginal: stigmal (27:18).

*Male*.—Similar to female except: body length 1.9 mm. Face with white area almost touching eye laterally; legs white; dorsal metasoma with large central white spot, dark brown posteriorly; antenna with scape white, slightly swollen on ventral surface, with sensory area slightly darker and with several irregular rows of sensillae extending for about 3/4 length (Fig. 32); funicle ratios 13:13:14:13:18, width about 6 anteriorly to 7 posteriorly, with numerous semierect brown setae on each flagellomere.

*Hosts*.—*Euscirrhopterus poeyi* (Noctuidae).

*Distribution*.—Known only from the type locality.

*Types*.—Holotype female: Costa Rica, Guanacaste Prov., Area de Conservación Guanacaste, Lambert N313800 E359800, 300m., V. 21, 1994, 94-SRNP-1656, D.H. Janzen & W. Hallwachs. ex. *Euscirrhopterus poeyi* (deposited in INBIO). Paratypes: 6 females and 1 male with same data as holotype (deposited in USNM).

*Etymology*.—This species is named in honor of Ivon Traña Medrano in special recognition of her dedicated attention to the dining operations in Sector Santa Rosa of the Area de Conservación Guanacaste.

***Euplectrus josei* Schauff, new species**  
(Figs. 35, 54–57)

*Diagnosis*.—Face below and between toruli yellow; dorsally with two pairs of minor seta ss2 between posterior ocelli (Fig. 54); posterior margin of eye nearly contiguous with posterior margin of head over

most of length. Male antenna with scape white, slightly swollen (Fig. 57), with narrow, elongate sensory area containing 2 irregular rows of sensillae extending almost entire length (Fig. 35).

This species is recognizable by two characters: 2 pairs of setae between the lateral ocelli (ss2) and the posterior margin of the eye contiguous with the posterior margin of the head. *Euplectrus floryae* also has two pairs of ss2 setae, but the yellow color on the face runs to and partially up the margin of the eyes whereas in *josei* it is restricted to between and below the toruli.

*Description*.—Female. Body length 2.2–2.5 mm. Color: body mostly black except the following: face below and between toruli yellow; antenna with scape white to light yellow, flagellum yellow; mandibles yellow; legs light yellow to white; dorsal metasoma with large central yellow to white area extending from just behind petiole posteriorly about 1/2–2/3 length of dorsum, becoming darker brown posteriorly, lateral margin brown anteriorly, then yellow medially and becoming dark brown posteriorly; ventral metasoma yellow to white. *Head*. Dorsally with two pairs of minor seta ss2 between posterior ocelli, inserted adjacent to occipital carina (Fig. 54), all setae S1–6 present, setal row sr2 present as 1–2 irregular rows of 12–15 setae reaching the bottom of the eye; occipital carina weak medially; width of eye: width of face: 35:15, posterior margin eye of nearly contiguous with posterior margin of head over most of length. Ratio of MS:EH 13:33; lateral ocellus less than 1 diameter from eye (OD:OOD 8:5). Face below eyes rounded, not abruptly narrowing. Vertex under anterior ocellus reticulate to alutaceous. Toruli separated by about 2× their own diameters. Malar suture absent below eye. Area under eye lightly reticulate to alutaceous. Scape 4× as long as wide. Ratio of funicular segments 13:13:13:12:19, width 7 at F1 to 8 at club, flagellar segments without small

whorls of brown setae basally. *Mesosoma*. Pronotum anterior to transverse carina with scattered setae, finely rugosely reticulate, posterior to carina more openly reticulate and shiny. Mesoscutum (Fig. 55) reticulate, becoming more smooth, and shiny posteriorly. Midlobe with median carina fading over anterior 1/4, otherwise complete, slightly sunken posteriorly, with no small setae antero-laterally, posterior setae even with surface. Dorsal axillar/scutellar margin with broad, nearly straight deep furrow with flat bottom. Axillae shiny, openly reticulate. Scutellum reticulate to alutaceous, smooth along posterior margin, slightly pointed at anterior margin with axillae. Metanotum bordered anteriorly by narrow band of small alveoli, medially shiny and lightly reticulate with anterior edge slightly projected outward. Propodeum laterad of median carina shiny and smooth to very lightly reticulate to the step-like plica, median carina with anterior cup-like flange nearly triangular, slightly invaginated. Area around spiracle reticulate, openly reticulate laterally, spiracle slightly raised above surface and slanted so that opening is at a slight angle to the surface (Fig. 56), with antero-lateral flange present and obvious, with 8–12 setae laterad and below spiracle. Posterior margin of propodeum with a deep alveolus at posterior margin adjacent to plica. Petiole in dorsal view slightly longer than wide (11:10), rugose dorsally with irregular longitudinal carina and smooth at posterior margin. *Metasoma*. Ovate, about 1.5–2× as long as wide. Legs. Ratio of hind tibial spur 1:spur 2:tarsus 1:T2:T3:T4. 34:25:23:16:10:15. Forewing. Hyaline, about 2.3× as long as wide. Costal cell with 2 irregular rows of setae ventrally. Venation yellow to white, ratio of post-marginal: stigmal (30:18).

*Male*.—Similar to female except: Body length 2.25 mm. Antenna with scape white, (Figs. 35, 57) slightly swollen, with narrow, elongate sensory area containing 2 irregular rows of sensillae extending al-

most entire length; funicle ratios 14:14:14:14:20 width 6–7, with scattered or whorled semierect brown setae on each flagellomere.

*Hosts*.—*Pactes Imodes* (Noctuidae).

*Distribution*.—Known only from the ACG.

*Types*.—Holotype female: Costa Rica, Guanacaste Prov., Area de Conservación Guanacaste, Lambert N314800 E360500, 300m., VII. 8, 1993, 93-SRNP-3064, D.H. Janzen & W. Hallwachs. ex. *Pactes Imodes* (deposited in INBIO). Paratypes: 2 males with the same data as holotype; other specimens with some of the same information as holotype are except: 2 females with Lambert N313800 E359800, 300m., VII. 17. 1984, 84-SRNP-1504; 2 males and 1 female with Lambert N313800 E359800, 300m., VII. 18. 1984, 84-SRNP-1433; 2 females with Lambert N314800 E360500, 300m., VII. 6. 1993, 93-SRNP-2869; 1 male and 1 female with Lambert N313800 E359800, 300m., VII. 4. 1993, 93-SRNP-2871; 1 male with Lambert N314800 E360500, 300m., VII.7.1993, 93-SRNP-3093; 2 males and one female with Lambert N314400 E358900, 280m., VII.4.1995, 95-SRNP-6055 (deposited in USNM, BMNH, and CNC).

*Etymology*.—This species is named in honor of José Eras Pineda in special recognition of his dedicated management of the dining operations in Sector Santa Rosa of the Area de Conservación Guanacaste.

*Euplectrus magdae* Schauff, new species  
(Figs. 33, 58–60)

*Diagnosis*.—Face below and between toruli yellowish brown (as in Figs. 13, 14); legs light yellow to white; one pair of small setae (ss2) between lateral ocelli (as in Fig. 54); all major setae S1–6 present; metanotum bordered anteriorly by a large nearly continuous invagination sometimes divided medially into two alveoli (Fig. 59); propodeum laterad of median carina reticulate, median carina with anterior cup-like flange nearly triangular and only slightly



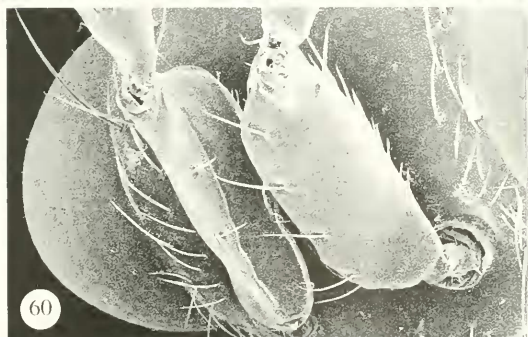
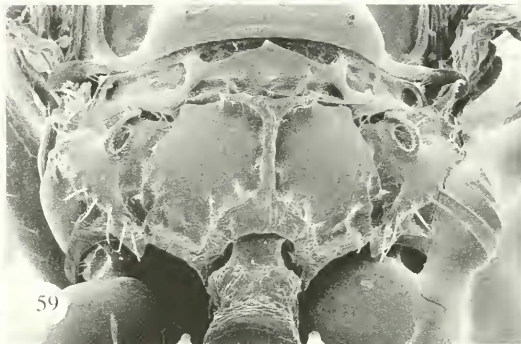
invaginated; petiole wider than long. Male antenna with scape white, swollen on lateral surface (Fig. 60), with sensory area invaginated and with 3–4 irregular rows of sensillae extending nearly entire length (Fig. 33).

This species is similar to *E. auae* which shares the yellow face, yellow legs, and presence of all 6 pairs of large facial setae. In *E. auae* the petiole is longer than wide while in *E. magdae* the petiole is slightly wider than long. The male scape of *E. magdae* is more swollen and sunken with a larger sensory area than in *E. auae* (Fig. 34).

*Description.*—Female. Body length 2.2–2.6 mm. Color: body mostly black except the following: face below and between toruli yellowish brown; antenna with scape white to light yellow, flagellum yellow to light brown; mandibles yellow to white; legs light yellow to white; dorsal metasoma with large central yellow area extending from just behind petiole posteriorly for about 1/2 length, roughly hourglass shaped posteriorly dark brown to black, ventral metasoma yellow in anterior half, brown posteriorly. *Head.* Dorsally with one pair of minor seta ss2 between posterior ocelli (as in Fig. 70), inserted distinctly above occipital carina, all setae S1–6 present, setal row sr2 present as 2–3 irregular rows of 20–25 setae reaching the bottom of the eye; occipital carina present medially; width of eye: width of face 14:40, posterior margin of eye separated from margin of head ventrally. Ratio of MS:EH 16:30; lateral ocellus more than 1 diameter from eye (OD:OOD 14:10). Face below eyes rounded, not abruptly narrowing. Vertex under anterior ocellus smooth to lightly reticulate. Toruli separated by about 2X their own diameters. Malar suture absent. Area under eye smooth. Scape 4X as long as wide. Ratio of funicular segments 14:14:14:14:19, width 6 at F1 to 7 at club, each flagellar segment with 1–2 irregular whorls of brown setae basally. *Mesosoma.* Pronotum anterior to transverse

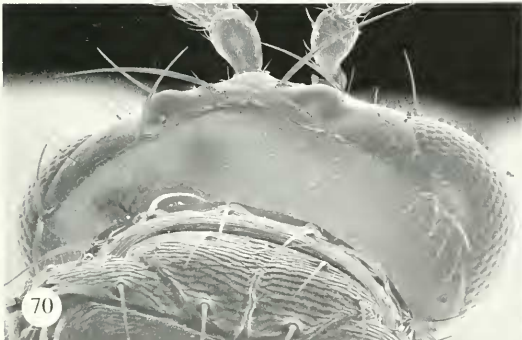
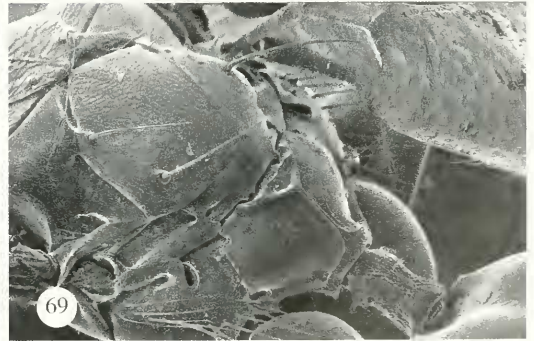
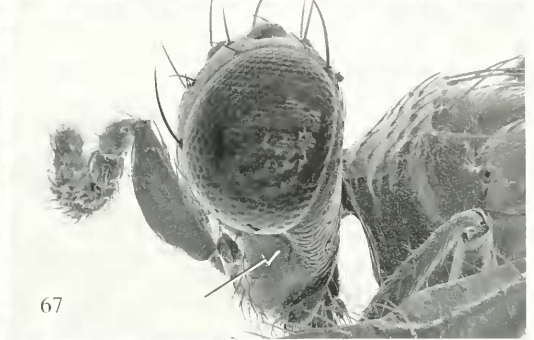
carina with scattered setae, finely rugosely reticulate, posterior to carina more openly reticulate and shiny. Mesoscutum (Fig. 58) reticulate, becoming more smooth, and shiny posteriorly. Midlobe with median carina fading only at extreme anterior margin, otherwise complete, slightly sunken posteriorly, with no small setae antero-laterally, posterior setae even with surface. Dorsal axillar/scutellar margin with broad, curved deep furrow with flat bottom. Axillae shiny, openly reticulate. Scutellum finely reticulate to alutaceous, shiny, more nearly rounded anteriorly at margin with axillae. Metanotum bordered anteriorly by a large nearly continuous invagination sometimes divided medially into two alveoli, medially shiny and lightly reticulate, without median carina below. Propodeum (Fig. 59) laterad of median carina reticulate to the step-like plica, median carina with anterior cup-like flange nearly triangular and only slightly invaginated. Area around spiracle finely reticulate, lateral edge of spiracle raised above surface, with antero-lateral flange reduced, with 7–8 setae laterad and below spiracle. Posterior margin of propodeum without irregular alveolae and carinae. Petiole in dorsal view slightly wider than long (15:12) and rugose dorsally. *Metasoma.* Ovate, about 1.7–2× as long as wide. Legs. Ratio of hind tibial spur 1:spur 2: tarsus 1:T2:T3:T4. 40:30:27:16:11:18. Forewing. Hyaline, about 2.5× as long as wide. Costal cell with 2 irregular rows of setae ventrally. Venation yellow to white, ratio of postmarginal: stigmal (33:17).

*Male.*—Similar to female except: body length 1.9 mm. Face with white area slightly broader; legs white with distal femora, tibiae, and tarsi sometimes yellow; dorsal metasoma with large central white spot, dark brown posteriorly; antenna with scape white, (Figs. 33, 60) swollen on ventral surface, with sensory area invaginated and with 3–4 irregular rows of sensillae extending nearly entire length; funicle ratios 13:13:14:13:18, width about 6



Figs. 56–63. *Euplectrus* scanning electron micrographs. 56–57, *E. josei*. 56, Propodeum. 57, Male scapes. 58–60, *E. magdae*. 58, Dorsal mesosoma. 59, Propodeum. 60, Male scapes. 61–63, *E. mariae*. 61, Dorsal mesosoma. 62, Male head and scape. 63, Closeup of male scape.





Figs. 64–71. *Euplectrus* scanning electron micrographs. 64–67, *E. orias*. 64, Dorsal mesosoma. 65, Propodeum. 66, Head, dorsal view. 67, Head, lateral view. 68–69, *E. rojasi*. 68, Dorsal mesosoma. 69, Propodeum, lateral view. 70–71, *E. romitzi*. 70, Head and mesosoma. 71, Dorsal mesosoma.



anteriorly to 7 posteriorly, with whorled semi-erect brown setae on base of each flagellomere.

*Hosts*.—*Dasylophia maxtla*, *D. basitincta*, *D. nr. goraxa* (all Notodontidae).

*Distribution*.—Known only from the ACG.

*Types*.—Holotype female: Costa Rica Guanacaste Prov., Area de Conservación Guanacaste, Lambert N318600 E375150, 560m., IX.12.1995, 95-SRNP-9001, ex. *Dasylophia maxtla*, D.H. Janzen & W. Hallwachs (deposited in INBIO). Paratypes: 5 males and 25 females with same data as holotype (deposited in USNM, BMNH, CNC).

*Other specimens examined*.—All from the ACG, 4 specimens 94-SRNP-6167, ex. *Chliara croesus*; 4 specimens 96-SRNP-11096; 1 specimen 93-SRNP-2905, ex. *Dasylophia basitincta*, 4 specimens 87-SRNP-1302, ex. *Dasylophia not basitincta*.

*Etymology*.—This species is named in honor of María Magdalena Rodríguez Rodríguez in special recognition of her dedicated management of the main Administrative Office of the Area de Conservación Guanacaste.

***Euplectrus mariae* Schauf, new species**  
(Figs. 30, 61–63)

*Diagnosis*.—Face below and between toruli yellow, extending slightly laterad of toruli, but not reaching eye (as in Fig. 13); one pair of setae ss2 between posterior ocelli, seta S5 absent (see Fig. 23); mesoscutal midlobe without small setae anteriorly; propodeum (Fig. 61) lightly reticulate, often with irregular carinae laterad of median carina and appearing somewhat rugose; petiole in dorsal view wider than long. Male antenna with scape white, slightly swollen, with brown, elongate narrowly ovate sensory area containing 2–3 irregular rows of sensillae extending about 2/3 length (Fig. 30).

This species is very similar to *E. ronniei* which also has a yellow face and lacks seta S5. *Euplectrus mariae* can be distinguished

from *ronniei* by the petiole which is as wide as long in that species, but wider than long in *magdae*. The male scape of *ronniei* has the small brown sensory area much shorter (Fig. 31) and with only a single row of sensillae while in *mariae* the sensory area is long and with at least two irregular rows of sensillae (Figs. 30, 62, 63).

*Description*.—Female. Body length 2.1–2.3 mm. Color: body mostly black except the following: face below and between toruli yellow, extending slightly laterad of toruli but not reaching eye; antenna with scape white to light yellow, flagellum yellow or light brown; mandibles yellow to white; legs light yellow to white; dorsal metasoma with large central yellow to white area extending from just behind petiole posteriorly about 2/3 to 3/4 length of dorsum, becoming slightly darker posteriorly, lateral brown margin continuous over length, ventral metasoma yellow to white. *Head*. Dorsally with one pair of minor seta ss2 between posterior ocelli, seta S5 absent, setal row sr2 present as 1–3 irregular rows of 20–25 setae reaching the bottom of the eye; occipital carina fading medially; width of eye: width of face 11:33, posterior margin eye of nearly contiguous with posterior margin of head most of length; ratio of MS:EH 15:30; lateral ocellus more than 1 diameter from eye (OD:OOD 6:8). Face below eyes rounded, not abruptly narrowing. Vertex under anterior ocellus reticulate. Toruli separated by about 2× their own diameters. Malar suture absent. Area under eye lightly reticulate. Scape 6× as long as wide. Ratio of funicular segments 12:12:12:13:17, width 6 at F1 to 7 at club, flagellar segments without small whorls of brown setae basally. *Mesosoma*. Pronotum anterior to transverse carina with scattered setae, finely rugosely reticulate, posterior to carina more openly reticulate and shiny. Mesoscutum (Fig. 61) reticulate, becoming more smooth, and shiny posteriorly. Midlobe with median carina fading over an-

terior 1/4, otherwise complete, slightly sunken posteriorly, with no small setae antero-laterally, posterior setae even with surface or slightly raised. Dorsal axillar/scutellar margin with broad, nearly straight deep furrow with narrow, but flat bottom. Axillae shiny, openly reticulate. Scutellum shiny and lightly reticulate to alutaceous, pointed at anterior margin. Metanotum bordered anteriorly by a narrow band of small alveoli, medially shiny and lightly reticulate. Propodeum laterad of median carina shiny and openly reticulate to the step-like plica, median carina with anterior cup-like flange rounded and invaginated. Area around spiracle granulate medially, openly reticulate laterally, spiracle slightly raised above surface parallel to the surface of the propodeum, with antero-lateral flange large and obvious, with 8–9 setae laterad and below spiracle. Petiole in dorsal wider than long (20:15) and rugose dorsally with irregular longitudinal carina and smooth at posterior margin. *Metasoma*. Ovate, about 1.5–2× as long as wide. Legs. Ratio of hind tibial spur 1:spur 2:tarsus 1:T2:T3:T4. 32:25:18:14:8:20. Forewing. Hyaline, about 2.3× as long as wide. Costal cell with 2 irregular rows of setae ventrally. Venation yellow to white, ratio of postmarginal: stigmal (32:18).

*Male*.—Similar to female except: Body length 1.7–1.9 mm. Face yellow to white, legs white to light yellow, metasoma with central white spot extending only about 1/2 to 2/3 of length, dark brown posteriorly, laterally dark brown to light brown. Antenna (Figs. 30, 62, 63) with scape white, slightly swollen, with brown, elongate narrowly ovate sensory area containing 2–3 irregular rows of sensillae extending about 2/3 length (Fig. 30); funicle ratios 11:10:11:11:16, width 6–7, without scattered or whorled semierect brown setae on each flagellomere.

*Hosts*.—*Concana Mundissima* (Noctuidae), *Elymiotis attenuata* (Notodontidae), *Dasylophia* nr. *goraxa* (Notodontidae).

*Distribution*.—Known only from Guanacaste.

*Types*.—Holotype female: Costa Rica, Guanacaste Prov., Area de Conservación Guanacaste, Lambert N309700 E352300, 5m., V. 18, 1994, 94-SRNP-1063, D.H. Janzen & W. Hallwachs. ex. *Concana mundissima* (deposited in INBIO). Paratypes: 2 females and 1 male all with the same data as holotype; other specimens with some of the same information are except: 3 males and 1 female with Lambert N316100 E360300, 310m., VI. 13. 1993, 93-SRNP-1585; 1 male and 3 females with Lambert N318500 E359850, 240m., V. 24. 1992, 92-SRNP-3032; 1 female with Lambert N309700 E352300, 5m., V. 19. 1994, 94-SRNP-1083; 2 males with Lambert N309700 E352300, 5m., V.16.1994, 94-SRNP-1075; 1 female with Lambert N309700 E352300, 5m., V.16.1994, 94-SRNP-1071; 1 female with Lambert N316100 E360300, 310m., VI.15.1993, 93-SRNP-1577; 2 males with Lambert N309700 E352300, 5m., V.19.1994, 94-SRNP-1217; 1 female with Lambert N316100 E360300, 300m., VI.14.1993, 93-SRNP-1583; 1 female with Lambert N309700 E352300, 5m., V.16.1994, 94-SRNP-1088; 1 male with Lambert N309700 E352300, 5m., V.24.1994, 94-SRNP-1216; 1 male and 1 female with Lambert N309700 E352300, 5m., V.15.1994, 94-SRNP-1055; 1 male and 1 female with Lambert N309700 E352300, 5m., V.19.1994, 94-SRNP-1160; 1 male with Lambert N309700 E352300, 5m., V.18.1994, 94-SRNP-1081; 1 male and 1 female with Lambert N309700 E352300, 5m., V.14.1994, 94-SRNP-1102; 1 female with Lambert N318500 E359850, 240m., VII.22.1992, 92-SRNP-3141; 1 male with Lambert N318500 E359850, 240m., VII.19.1992, 92-SRNP-2923; 1 female with Lambert N318500 E359850, 240m., VII.22.1992, 92-SRNP-3142; 1 male with Lambert N309700 E352300, 5m., V.18.1994, 94-SRNP-1159; 1 female with Lambert N309700 E352300, 5m., V.16.1994, 94-SRNP-1090; 1 male, 2 females with Lam-

bert N318500 E359850, 240m., VII.19.1992, 92-SRNP-2924; 1 female with Lambert N312150 E357200, 250m., VII.24.1992, 92-SRNP-3297; 1 male with Lambert N309700 E352300, 5m., V.18.1994, 94-SRNP-1093; 1 female with Lambert N318500 E359850, 240m., VII.19.1992, 92-SRNP-2924; 1 male and 1 female with Lambert N314800 E360500, 300m., VII.27.1993, 93-SRNP-3731; 1 male and 1 female with Lambert N314800 E360500, 300m., VII.23.1992, 92-SRNP-4426; 1 male with Lambert N314800 E360500, 300m., VII.23.1994, 94-SRNP-5595; 1 female with Lambert N309450 E355300, 10m., VI.5.1992, 93-SRNP-993; 2 males and 1 female with Lambert N308900 E355700, 10m., V.24.1996, 96-SRNP-1314; 1 female with Lambert N316100 E360300, 310m., VI.14.1993, 93-SRNP-1582; 1 male and 1 female with Lambert N314800 E360500, 300m., VII.19.1994, 94-SRNP-5588; 1 male with Lambert N314800 E360500, 300m., VII.31.1991, 91-SRNP-2245 (paratypes deposited in USNM, INBIO, BMNH, and CNC).

*Other specimens examined.*—3 specimens 92-SRNP-4431, ex. *Elymiotis* sp.; 2 specimens 91-SRNP-1091, ex. *Concana mundissima*.

*Etymology.*—This species is named in honor of María De Los Angeles Guevara Rojas in special recognition of her dedicated attention to the dining operations in Sector Santa Rosa of the Area de Conservación Guanacaste.

***Euplectrus orias* Schauff, new species**  
(Figs. 15, 37, 64–67)

*Diagnosis.*—Female face below toruli dark brown (Fig. 15), legs with midcoxa brown and hind coxa brown to black, hind femur brown distally; antenna with scape yellow, flagellum yellow or light brown; mandibles yellow; with one pair of minor seta ss2 between posterior ocelli (Fig. 66), malar suture present below eye (Fig. 67); petiole as wide as long.

This is one of a small group of species

with a dark face and dark hind coxae (*zamorai*, *valverdei* and *rojasi*). It can be differentiated from *zamorai*, *rojasi*, and *valverdei* by the presence of a single pair of ss2 setae between the lateral ocelli (setae absent in *zamorai*, *rojasi*, and *valverdei*). In addition, in *zamorai* the antennal flagellum has the last two segments distinctly darker than the preceding segments (segments only gradually becoming darker in *orias*). In *E. xiomarae*, which also has a dark face and hind coxae, the malar suture is absent (this suture can be difficult to assess since it is often weakly expressed so caution is urged).

*Description.*—Female. Body length 1.6–1.7 mm. Color: body mostly black except the following: face below and between toruli brown (Fig. 15); antenna with scape yellow, flagellum yellow or light brown; mandibles yellow; legs yellow-brown except midcoxa brown, hind coxa mostly dark brown to black, hind femur with distal half brown; dorsal metasoma with large central yellow area extending from just behind petiole posteriorly about 1/2 length of dorsum, becoming darker brown posteriorly, lateral margin brown, ventral metasoma yellow in anterior half, then dark brown. *Head.* Dorsally with one pair of minor seta ss2 between posterior ocelli, inserted adjacent to occipital carina (Fig. 66), all setae S1–6 present, setal row sr2 present as 1–2 irregular rows of 8–10 setae reaching the bottom of the eye; occipital carina weak medially; width of eye: width of face:12:39, posterior margin eye of not nearly contiguous with posterior margin of head over most of length; ratio of MS:EH 12:24; lateral ocellus more than 1 diameter from eye (OD:OOD 8:12). Face below eyes rounded, not abruptly narrowing. Vertex under anterior ocellus reticulate. Toruli separated by about 2.5× their own diameters. Malar suture present below eye, fading ventrally. Area under eye lightly reticulate to alutaceous. Scape 4× as long as wide. Ratio of funicular segments 8:7:7:8:12, width 5 at F1 to 6 at club,



flagellar segments with small whorls of brown setae basally. *Mesosoma*. Pronotum anterior to transverse carina with scattered setae, finely rugosely reticulate, posterior to carina more openly reticulate and shiny. Mesoscutum (Fig. 64) reticulate, becoming more smooth, and shiny posteriorly. Mid-lobe with median carina well developed, fading over anterior 1/4, otherwise complete, not noticeably sunken posteriorly, with no small setae antero-laterally, posterior setae even with surface. Dorsal axillar/scutellar margin with broad, nearly straight deep furrow with flat bottom. Axillae shiny, openly reticulate. Scutellum shiny, lightly reticulate to alutaceous, smooth along posterior margin, slightly pointed at anterior margin with axillae. Metanotum bordered anteriorly by a narrow band of small alveoli, medially shiny and lightly reticulate (Fig. 65). Propodeum laterad of median carina shiny and smooth to the step-like plica, median carina with anterior cup-like flange rounded and invaginated. Area around spiracle granulate medially, openly reticulate laterally, spiracle slightly raised above surface and slanted so that opening is at a slight angle to the surface, with antero-lateral flange present, but somewhat reduced, with 6–8 setae laterad and below spiracle. Petiole in dorsal as wide as long (12:12), rugose dorsally with irregular longitudinal carina and smooth at posterior margin. *Metasoma*. Ovate, about 1.1–1.5× as long as wide. Legs. Ratio of hind tibial spur 1:spur 2:tarsus 1:T2:T3:T4. 32:22:20:13:8:12. Forewing. Hyaline, about 2.3× as long as wide. Costal cell with 2 irregular rows of setae ventrally. Venation yellow to white, ratio of postmarginal: stigmal (16:12).

*Male*.—Similar to female except: body length 1.6mm; antenna with scape white, slightly swollen, with narrow, elongate sensory area containing 2 irregular rows of sensillae extending about 3/4 length (Fig. 37); funicle ratios 7:7:7:7:11 width 5–

6, with scattered or whorled semi-erect brown setae on each flagellomere.

*Hosts*.—Unknown Geometridae.

*Distribution*.—Widely distributed in Costa Rica.

*Types*.—Holotype female: Costa Rica, Guanacaste Prov., Area de Conservación Guanacaste, Lambert N314800 E360500, 300m., VI. 24, 1993, 93-SRNP-2241, D.H. Janzen & W. Hallwachs. ex. Geometridae (deposited in INBIO). Paratypes: 7 females and 1 male with the same data as holotype; 1 female Costa Rica: Alajuela, 5km W. San Ramon, 1200m, IV. 1997, O. Castro & P. Hanson; 2 females Costa Rica: Puntarenas, San Vito, Estac. Biol. Las Alturas, 1500m, IV. 1992, Hanson & Godoy; 1 female Costa Rica: Cartago, 4km NE Cañon, Genesis II, 2300m, VIII. 1995, P. Hanson; 1 female Costa Rica: San José, Zurqui de Moravia, 1600m, X-XII. 1990, col. P. Hanson; 1 female Costa Rica: San José, Cerro de la Muerte, 19km S,3W Empalme, 2600m, IX. 1992, Hanson & Godoy; 1 female Costa Rica: Puntarenas, 23km N. Puerto Jiménez, LaPalma, 10m, XI-XII. 1992, col. P. Hanson (deposited in USNM with 1 female each to CNC and BMNH).

*Etymology*.—This species is named in honor of Julio Diaz Orias in special recognition of his many years of steadfast and energetic management of the fire prevention and control program of the Area de Conservación Guanacaste.

*Euplectrus rojasi* Schauff, new species  
(Figs. 68, 69)

*Diagnosis*.—Face below toruli dark yellow, brown under and between toruli; mandibles yellow; hind coxa mostly black; posterior margin of scutellum overlapping anterior metanotum (Figs. 68, 69); anterior extension of median propodeal carina flattened, not cup-like; petiole 1.5X as long as wide.

The flattened anterior cup-like flange of the median propodeal carina in this species is quite distinctive with anterior end of median carina usually expanded into a

rounded or triangular and invaginated "cup." In addition, this is the only specimen I have examined where the face under the toruli is brown medially between the toruli and becomes yellow laterally under the toruli. Of the species treated here, the anterior edge of the metanotum being covered by the posterior margin of the scutellum is also unusual. However, in *E. carlowae*, the lateral margins of the scutellum project over the lateral edges of the metanotum and the senior author has seen other specimens of apparently undescribed species which also have the scutellum overhanging the metanotum.

*Description*.—Female. Body length 2.2 mm. Color: body mostly black except the following: antenna with scape yellow to brown, pedicle becoming dark brown apically, flagellum light brown becoming darker brown apically; mandibles yellow; enlarged setae on vertex yellowish brown; legs yellow except hind coxa mostly black; dorsal metasoma mostly dark brown to black with small yellow spot antero-medially, ventral metasoma dark brown behind petiole, then yellow to about midpoint, then dark brown. *Head*. Dorsally with 5 minor seta ss2 between posterior ocelli, all seta S1–6 present, setal row sr2 present as 2 irregular rows of 15–20 setae reaching to bottom of eye; occipital carina weak medially; width of eye: width of face (35:13), posterior margin eye of not nearly contiguous with posterior margin of head over most of length. Ratio of MS:EH 16:30; lateral ocellus more than 1 diameter from eye (OD:OOD 5:8). Face below eyes rounded, not abruptly narrowing. Vertex under anterior ocellus reticulate to alutaceous. Toruli separated by about 2 $\times$  their own diameters. Malar suture absent. Area under eye lightly reticulate. Scape 6 $\times$  as long as wide. Ratio of funicular segments 10:11; 11:11:18, width 5 at F1 to 6 at club, flagellar segments with small whorls of brown setae basally. *Mesosoma*. Pronotum anterior to transverse carina with scattered setae, finely rugosely reticulate, posterior to

carina reticulate and shiny. Mesoscutum (Fig. 68) reticulate, becoming more smooth, and shiny posteriorly. Midlobe with median carina fading in anterior half, not noticeably sunken posteriorly, with no small setae antero-laterally, posterior setae even with surface. Dorsal axillar/scutellar margin with narrowed, nearly straight deep furrow without flat bottom except medially. Axillae openly reticulate. Scutellum reticulate to alutaceous, smooth along posterior margin, posterior margin extended over anterior margin of metanotum, anterior margin pointed. Metanotum anteriorly covered by scutellum, medially shiny and smooth to lightly reticulate (Fig. 69). Propodeum laterad of median carina shiny and smooth to the step-like plica with occasional slight hints of reticulation, median carina with anterior cup-like flange flattened, not expanded and cup-like. Area around spiracle reticulate, spiracle slightly raised above surface and tilted toward median carina, with antero-lateral flange present, with 11 setae laterad and below spiracle. Petiole in dorsal view 1.5 $\times$  as long as wide (15:10), rugose dorsally. *Metasoma*. Ovate, about 1.5 $\times$  as long as wide. Legs. Ratio of hind tibial spur 1: spur 2:tarsus 1:T2:T3:T4. 40:27:30:16:10:16. Forewing. Hyaline, about 2.3 $\times$  as long as wide. Costal cell with 1–2 irregular rows of setae ventrally. Venation yellow light brown, ratio of postmarginal: stigmal (41:23).

*Male*.—Unknown.

*Hosts*.—Unknown.

*Distribution*.—Known only from the type locality.

*Types*.—Holotype female on point (antenna and wing slide-mounted) with data "Costa Rica, Cartago, 4 Km. NE., Cañon Genesis II, 2350M. VI. 1995. P. Hanson." (deposited in USNM).

*Notes*.—The presence of 5 setae ss2 is probably an anomaly. Other specimens rarely show 1 seta or 3 setae when the usual number is 0, 2, or 4. In this case, the

usual number for this species is probably 4 setae in this location.

*Etymology.*—This species is named in honor of Maria Zulay Guevara Rojas in special recognition of her dedicated attention to the Research Center and the dormitories in Sector Santa Rosa of the Area de Conservación Guanacaste.

***Euplectrus ronniei* Schauff, new species**  
(Figs. 31, 70, 71, 72, 73)

*Diagnosis.*—Face below and slightly laterad of toruli yellow; with one pair of setae ss2 between posterior ocelli (Fig. 70), seta S5 absent (see Fig. 23), scutellum shiny and lightly reticulate, petiole as wide as long. Male scape with small restricted brown spot on ventral surface, single short row of sensillae (Fig. 31).

This species is similar to *E. mariae* which has a similar overall appearance lacking the S5 setae and with a yellow face, but tends to be somewhat larger (generally over 2 mm) and the propodeum laterad of the median carina is nearly smooth whereas it is more irregularly rugose in *mariae*. *Euplectrus ronniei* is most easily diagnosed by the scape (Figs. 31, 73) of the males which have a small restricted brown patch on the antero-ventral surface with only a single small row of sensillae.

*Description.*—Female. Body length 1.6–2 mm. Color: body mostly black except the following: face below and between toruli yellow, extending laterally below toruli, but not reaching eye; antenna with scape whitish, flagellum yellow; mandibles yellow; legs yellow to white; dorsal metasoma with large central yellow area extending from just behind petiole posteriorly about 1/2 length of dorsum, becoming darker brown posteriorly, lateral margin brown, ventral metasoma yellow to white in anterior half, then becoming dark yellow. *Head.* Dorsally with one pair of minor seta ss2 between posterior ocelli (Fig. 70), seta S5 absent, setal row sr2 present as 1–2 irregular rows of 13–15 setae reaching the bottom of the eye; occipital carina

weak medially; width of eye: width of face:12:35, posterior margin eye of not nearly contiguous with posterior margin of head over most of length; ratio of MS: EH 14:25; lateral ocellus more than 1 diameter from eye (OD:OOD 6:7). Face below eyes rounded, not abruptly narrowing. Vertex under anterior ocellus reticulate. Toruli separated by about 2× their own diameters. Malar suture absent below eye. Area under eye lightly reticulate to alutaceous. Scape 5× as long as wide. Ratio of funicular segments 9:9:9:14, width 5 at F1 to 6 at club, flagellar segments with small whorls of brown setae basally. *Mesosoma.* Pronotum anterior to transverse carina with scattered setae, finely rugosely reticulate, posterior to carina more openly reticulate and shiny. Mesoscutum (Fig. 71) reticulate, becoming more smooth, and shiny posteriorly. Midlobe with median carina well developed, fading over anterior 1/3 to 1/4, otherwise complete, not noticeably sunken posteriorly, with no small setae antero-laterally, posterior setae even with surface. Dorsal axillar/scutellar margin with broad, nearly straight deep furrow with narrow, but flat bottom. Axillae shiny, openly reticulate. Scutellum shiny, lightly reticulate to alutaceous, smooth along posterior margin, pointed at axillar/scutellar margin. Metanotum bordered anteriorly by narrow band of small alveoli, medially shiny and lightly reticulate. Propodeum (Fig. 72) laterad of median carina shiny and lightly reticulate to the step-like plica, median carina with anterior cup-like flange rounded and invaginated. Area around spiracle dull, openly reticulate laterally, spiracle slightly raised above surface and slanted so that opening is at a slight angle to the surface, with antero-lateral flange present, but somewhat reduced, with 9–12 setae laterad and below spiracle. Petiole in dorsal view as wide as long (11:11), rugose dorsally with irregular longitudinal carina and almost smooth at posterior margin. *Metasoma.* Ovale, about 1.4–1.5× as long as wide.



Legs ~~black~~ of hind tibial spur 1:spur 2: tarsus 1:T2:T3:T4. 28:16:20:12:8:13. Forewing. Hyaline, about 2.3× as long as wide. Costal cell with 2 irregular rows of setae ventrally. Venation yellow to white, ratio of postmarginal: stigmal (22:16).

*Male*.—Similar to female except: body length 1.6 mm. Face white to yellow; antennal scape with small brown spot at apical ventral margin (Fig. 31) very slightly swollen, with narrow sensory area containing only 1 irregular row of sensillae extending about 1/4 length; funicle ratios 9:10:10:10:17 width 5 near base, 6 at club, with few scattered or whorled semierect brown setae on each flagellomere; metasoma white in dorsal 1/2 then dark brown, ventrally yellow becoming dark brown posteriorly.

*Hosts*.—*Oxidercia toxea* (Noctuidae), *Cautethia spuria* (Sphingidae).

*Distribution*.—Known only from the ACG.

*Types*.—Female holotype: Costa Rica Guanacaste Prov., Area de Conservación Guanacaste, Lambert N314800 E360500, 300m., VII.26.1992, 92-SRNP-3415, ex. *Cautethia spuria*, D.H. Janzen & W. Hallwachs (deposited in INBIO). Paratypes: 3 males same as holotype except with Lambert N313400 E358900, 280m., VIII. 28.1995, 95-SRNP-8256, ex. *Oxidercia toxea*; 1 female with Lambert N314800 E360500, 300m., VII. 26.1992, 92-SRNP-3415, ex. *Cautethia spuria* (deposited in USNM)

*Etymology*.—This species is named in honor of Ronald Hernández D'Avanzo in recognition of his dedicated management of the Human Resources office of the Area de Conservación Guanacaste.

### *Euplectrus solitarius* Ashmead

*Euplectrus solitarius* Ashmead 1904:517.

*Diagnosis*.—Face under toruli honey yellow, lighter area restricted to just under toruli; all major seta 1–6 present (see Fig. 23); one pair of small setae (ss2) between posterior ocelli (as in Fig. 70); first funicle

2× as long as wide; legs yellow; scutellum reticulate; petiole longer than wide; metasoma ovate with small yellow spot antero-medially becoming brown then dark brown laterally and posteriorly.

This species is very similar to *E. comstockii* but can be differentiated by the petiole which is slightly wider than long (longer than wide in *solitarius*). In addition, the first funicle in *solitarius* is 3× as long as wide while in *comstockii* F1 is 2× as long as wide.

I have seen very few specimens of this species and it is defined here mostly on the basis of the holotype which is missing most of its antennae. I have seen no males that I can definitively attribute to this species.

*Distribution*.—Mexico south to Brazil and Ecuador

*Hosts*.—Unknown.

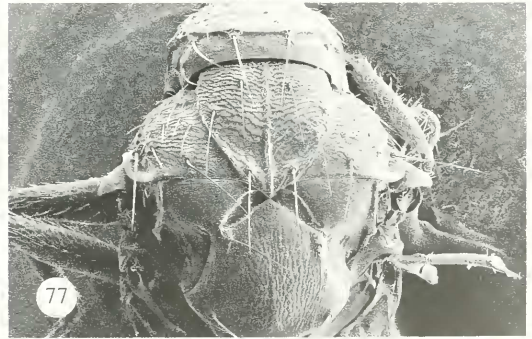
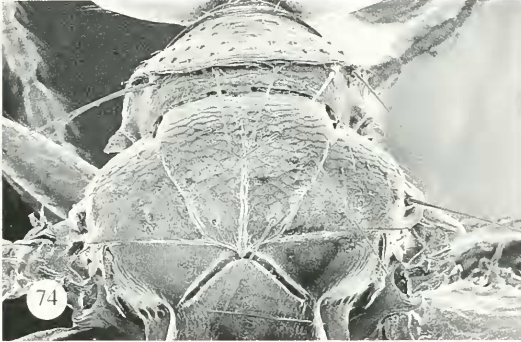
*Types*.—Holotype female deposited in USNM, type no. 60573. Erroneously labelled as a male, this type is missing most of the antennae.

### *Euplectrus valverdei* Schauff, new species

(Figs. 17, 20, 21, 38, 74, 75, 76)

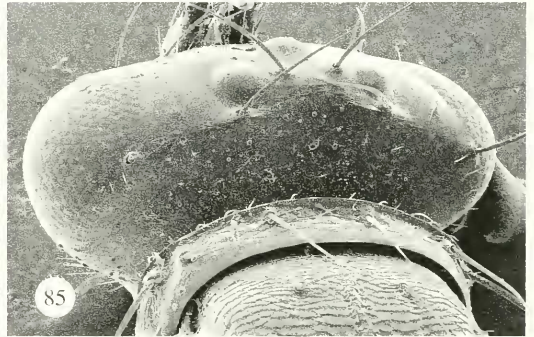
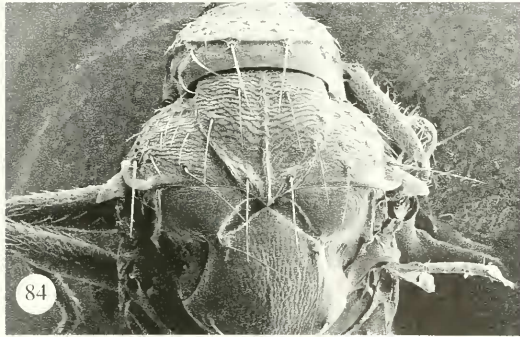
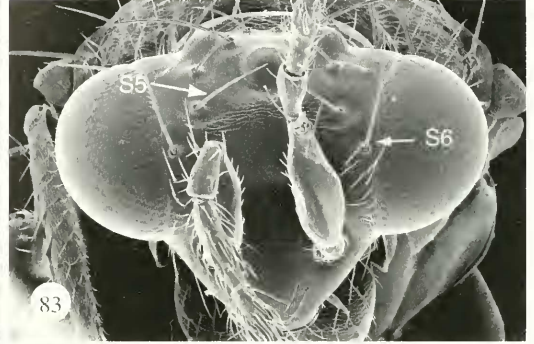
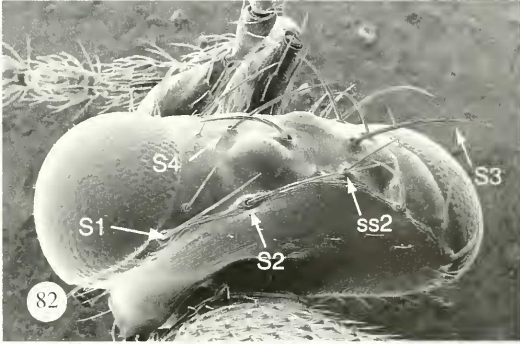
*Diagnosis*.—Face below toruli dark brown or black (as in Fig. 15); mandibles brown; hind femur and hind coxa darker than other legs (honey yellow to brown); minor seta ss2 absent between posterior ocelli (as in Fig. 82); anterior metanotum with narrow line of alveoli; malar suture visible at least near eye; propodeum laterad of median carina smooth. Male scape yellow and greatly swollen (Figs. 17, 38), surface covered with large sensillae (Figs. 20, 21, 75, 76).

In contrast to some of the other species with dark faces and hind coxae, the mandibles of this species are also brown (mandibles yellow in *xiomarae* and *orias*). The mandibles of *zamorai* are also brown, but that species has the antenna with the last two antennal flagellomeres dark contrasting sharply with the lighter preceding seg-



Figs. 72-79. *Euplectrus* scanning electron micrographs. 72-73, *E. ronnei*. 72, Propodeum. 73, Head, lateral view, male. 74-76, *E. valverdei*. 74, Dorsal mesosoma. 75, Male antennae and head. 76, Male scape. 77-79, *E. walteri*. 77, Dorsal mesosoma. 78, Propodeum. 79, Head.





Figs. 80–87. *Euplectrus* scanning electron micrographs. 80–84, *E. walteri*. 80, Head lateral view. 81, Head, ventro-lateral view. 82, Head, postero-dorsal view. 83, Head, frontal view. 84, Dorsal mesosoma. 85–87, *E. xiomarae*. 85, Head, postero-dorsal view. 86, Dorsal mesosoma. 87, Thorax and propodeum.



ments. In addition, *E. valverdei* has the malar suture at least partially complete while in *zamorai* and *xiomarae* it is absent. Males of this species are very distinctive with greatly enlarged yellow scapes (Fig. 17) covered on all surfaces with distinctly granular sensillae (when viewed on slide) (Figs. 20, 21).

*Description.*—Female. Body length 1.7–2.1 mm. Color: body mostly black except the following: antenna with scape white to yellow, flagellum yellow to light brown; mandibles brown; enlarged setae on vertex silver; legs white to yellow except hind coxa and distal half of hind femur honey yellow to brown; dorsal metasoma with large central inverted T-shaped yellow area extending from just behind petiole posteriorly about 1/2 length of dorsum, becoming darker brown posteriorly, lateral margin brown except medially, ventral metasoma yellow or white in anterior half, then dark brown. *Head.* Dorsally with minor seta ss2 absent between posterior ocelli, all setae S1–6 present, setal row sr2 present as 2–3 irregular rows of 15–20 setae reaching to bottom of eye; occipital carina weak to absent; width of eye: width of face (40:13), posterior margin eye of not nearly contiguous with posterior margin of head over most of length. Ratio of MS:EH 18:28; lateral ocellus more than 1 diameter from eye (OD:OOD 6:8). Face below eyes abruptly narrowing. Vertex under anterior ocellus reticulate to alutaceous. Toruli separated by about 2.5× their own diameters. Malar suture present, but irregular, marked in some specimens by change in sculpture. Area under eye lightly reticulate to alutaceous. Scape 5× as long as wide. Ratio of funicular segments 11:11:11:11:18, width 5 at F1 to 6 at club, flagellar segments with small whorls of brown setae basally. *Mesosoma.* Pronotum anterior to transverse carina with scattered setae, finely rugosely reticulate, posterior to carina reticulate and shiny. Mesoscutum reticulate, becoming more smooth, and shiny posteriorly. Midlobe

(Fig. 74) with median carina nearly complete, fading at extreme anterior margin, not noticeably sunken posteriorly, with no small setae antero-laterally, posterior setae even with surface. Dorsal axillar/scutellar margin with broad, nearly straight deep furrow without flat bottom. Axillae nearly smooth, shiny, with faint open reticulation, pointed at anterior margin with axillae. Scutellum shiny, very lightly alutaceous, smooth along posterior margin. Metanotum anteriorly with narrow but distinct band of small alveoli, medially shiny and smooth. Propodeum laterad of median carina shiny and smooth to the step-like plica with occasional faint hints of reticulation, median carina with anterior cup-like flange rounded and invaginated. Area around spiracle reticulate, spiracle slightly raised above surface and parallel to the surface, with antero-lateral flange present, with 12–15 setae laterad and below spiracle. Posterior margin of propodeum with deep alveolus at posterior margin. Petiole in dorsal view slightly longer than wide (15:12), rugose dorsally. *Metasoma.* Ovate, about 1.3–1.6× as long as wide. Legs. Ratio of hind tibial spur 1:spur 2:tarsus 1:T2:T3:T4. 38:29:28:15:10:14. Forewing. Infusate light brown, about 2.3× as long as wide. Costal cell with 1 irregular row of setae ventrally. Venation yellow light brown, ratio of postmarginal:stigmatal (22:16).

*Male.*—Similar to female except: scape yellow and greatly swollen (Figs. 17, 38, 75, 76) and surface covered with large granulate appearing sensillae (Figs. 20, 21); face very narrow below toruli; legs generally white except hind leg yellow; 12:13:14:14:20, width 4–6 with no noticeable brown setae.

*Hosts.*—Unknown

*Distribution.*—Known only from the type locality.

*Types.*—Holotype female: Costa Rica, San José, Ciudad Colón, 800m, II. 1990, Col. Luis Fournier (deposited in INBIO). Paratypes: 4 females with same data as the

holotype; 2 males and 1 female with same data as holotype except III-IV. 1990 (deposited in USNM and BMNH).

*Etymology*.—This species is named in honor of Julio A. Quirós Valverde in recognition of his many years of service and diligent management of police and protection services for the Area de Conservación Guanacaste.

***Euplectrus walteri* Schauff, new species**  
(Figs. 13, 29, 77–84, 89)

*Diagnosis*.—First funicular segment nearly equal in length to club (similar to Fig. 25), face below toruli yellow, with 1 pair of setae ss2 (as in Fig. 70) between posterior ocelli, toruli separated by about 4× their own diameter; posterior margin of eye nearly contiguous with posterior margin of head over most of length (as in Fig. 80, 82); scutellum heavily sculptured (Fig. 84); postmarginal vein almost 2× stigmal (see Fig. 18). Male F1 subequal to club, club swollen with broad, ovate sensory area containing several irregular rows of sensillae extending about 3/4 length (Fig. 30, 81).

The widely separated toruli and long first funicular segment (almost as long as the club) make this species easily recognizable among those with a yellow face. In addition, the scutellum is much more heavily sculptured than most of the other species. The antenna of *E. hansonii* is somewhat similar with F1 almost the same length as the club, but in that species all the funicles are elongated and about 3× as long as wide. In addition, the eyes of *walteri* are large and the hind margin is contiguous with the back of the head over most of its length.

*Description*.—Female. Body length 2.9–3.2 mm. Color: body mostly black except the following: face below and between toruli yellow (Fig. 13); antenna with scape white to light yellow, flagellum yellow or light brown; mandibles yellow to white; legs light yellow to white; dorsal metasoma with large central yellow to white area

extending from just behind petiole posteriorly about 1/2 length of dorsum, becoming darker brown posteriorly, lateral brown margin broken medially, ventral metasoma yellow to white. *Head*. Dorsally with one pair of minor seta ss2 between posterior ocelli (Fig. 82), inserted adjacent to occipital carina, setae S1–6 present, setal row sr2 present as 1–3 irregular rows of 15–20 setae reaching the bottom of the eye; occipital carina complete; width of eye: width of face:18:48, posterior margin eye of nearly contiguous with posterior margin of head of most of length; ratio of MS:EH 17:31; lateral ocellus more than 1 diameter from eye (OD:OOD 8:10). Face below eyes abruptly narrowing. Vertex below anterior ocellus alutaceous. Toruli separated by about 4× their own diameters (Fig. 13). Malar suture absent. Area under eye lightly reticulate. Scape 6× as long as wide. Ratio of funicular segments 19:17:17:15:20, width 8 at F1 to 9 at club, flagellar segments without small whorls of brown setae basally. *Mesosoma*. Pronotum anterior to transverse carina with scattered setae, finely rugosely reticulate, posterior to carina more openly reticulate and shiny. Mesoscutum reticulate (Fig. 84), nearly rugose anteriorly, becoming more smooth, and shiny posteriorly. Midlobe with median carina well developed, fading over anterior 1/4, otherwise complete, slightly sunken posteriorly, small setae antero-laterally usually absent, rarely with 2, posterior setae even with surface or slightly raised. Dorsal axillar/scutellar margin with broad, curved deep furrow with flat bottom. Axillae shiny, openly reticulate. Scutellum heavily reticulate to alutaceous, smooth along posterior margin, anteriorly distinctly pointed at axillar/scutellar margin. Metanotum bordered anteriorly by narrow band of small alveoli, medially shiny and lightly reticulate. Propodeum (Fig. 78) laterad of median carina shiny and openly reticulate to the step-like plica, median carina with anterior cup-like flange rounded and invaginated. Area

around spiracle granulate medially, openly reticulate laterally, spiracle slightly raised above surface and slanted so that opening is almost perpendicular to surface, with antero-lateral flange large and obvious, with 8–12 setae laterad and below spiracle. Posterior margin of propodeum without deep alveolus at posterior margin. Petiole in dorsal view as wide as long or very slightly longer than wide (11:12), rugose dorsally with irregular longitudinal carina and smooth at posterior margin. *Metasoma*. Ovate, about 1.1–1.5× as long as wide. Legs. Ratio of hind tibial spur 1:spur 2:tarsus 1:T2:T3:T4. 55:37:35:20:11:21. Forewing. Hyaline, about 2.3× as long as wide. Costal cell with 2 irregular rows of setae ventrally. Venation yellow to white, ratio of postmarginal: stigmal (42:22).

*Male*.—Similar to female except: body length 1.7–1.9 mm. Face yellow to white, legs white to light yellow, metasoma with central white spot only extending about 1/2 length, dark brown posteriorly, laterally dark brown to light brown, ventrally posterior half dark brown; antenna with scape white, swollen medially (Figs. 80, 81), with broad, ovate sensory area containing several irregular rows of sensillae extending about 3/4 length (Figs. 13, 29); funicle ratios 17:16:15:13:18, width 5–6, with scattered or whorled semierect brown setae on each flagellomere.

*Hosts*.—*Manduca barnesi*, *M. dilucida*, *M. florestan*, *M. lanuginosa*, *M. rustica*, *Perigonia ilus* (all Sphingidae).

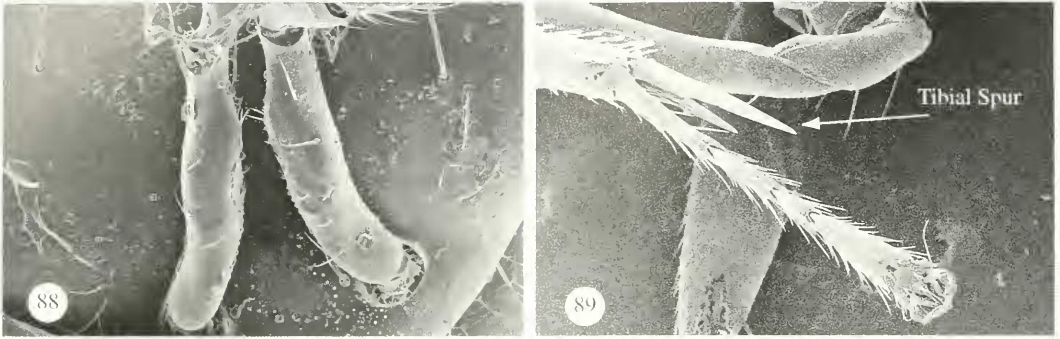
*Notes*.—Some setal variation on the mesoscutum has been observed in specimens of this species. While this character is generally very stable and no small setae are present, there are occasionally setae present antero-laterally near the anterior enlarged setae on the midlobe.

*Types*.—Holotype female: Costa Rica, Guanacaste Prov., Area de Conservación Guanacaste, Lambert N312450 E359500, 270m., VIII. 13, 1995, 95-SRNP-7544, D.H. Janzen & W. Hallwachs. ex. *Manduca flo-*

*restan* (deposited in INBIO). Paratypes: 2 females all with the same data as holotype; other specimens with some of the same information are except: 3 males and 1 female with Lambert N313100 E359900, 250m., VII. 30. 1992, 92-SRNP-3174; 3 males with Lambert N313100 E359900, 250m., VII. 30. 1992, 92-SRNP-4114; 2 males and 2 females with Lambert N313800 E359800, 300m., VI. 30. 1984, 84-SRNP-653, ex. *Manduca dilucida*; 1 male with Lambert N313800 E359800, 300m., VI. 23. 1993, 93-SRNP-2239 ; 1 female with Lambert N314800 E360500, 300m., VII.1.1984, 84-SRNP-805, ex. *Manduca dilucida*; 1 male and 2 females with Lambert N313100 E359900, 250m., VII.27.1992, 92-SRNP-3018, ex. *Manduca rustica*; 1 female with Lambert N315500 E360200, 300m., VIII.2.1992, 92-SRNP-3811; 2 females with Lambert N313100 E359900, 500m., VIII.1.1992, 92-SRNP-3708; 1 male with Lambert N317800 E362600, 300m., VI.28.1984, 84-SRNP-623, ex. *Manduca dilucida*; 1 female with Lambert N314800 E360500, 300m., VIII.16.1981, 81-SRNP-1141, ex. *Perigonia ilus*; 2 males and one female with Lambert N312450 E359300, 270m., VI.27.1996, 96-SRNP-6830; 1 female with Lambert N315500 E360200, 300m., VII.2.1992, 92-SRNP-2262, ex. *Manduca lanuginosa*; 2 females and 1 male with Lambert N313400 E358900, 280m., X.3.1996, 96-SRNP-10435; 1 female with Lambert N313800 E359800, 300m., XII.11.1990, 90-SRNP-2507, ex. *Manduca rustica*; 1 females and 1 male with Lambert N313400 E358900, 280m., VII.28.1991, 91-SRNP-1636; 2 females with Lambert N313400 E358900, 280m., VI.18.1994, 94-SRNP-4497, ex. *Manduca barnesi* (paratypes deposited in USNM, BMNH, and CNC).

*Etymology*.—This species is named in honor of Walter Bonilla Vásquez in special recognition of his dedicated management of the Accounting Office for the Area de Conservación Guanacaste.





Figs. 88–89. *Euplectrus* scanning electron micrographs. 88, *E. xiomarae*, Male scapes. 89, *E. walteri*, Hind tibia and tarsi.

*Euplectrus xiomarae* Schauff, new species

(Figs. 8, 9, 11, 19, 36, 85–87)

*Diagnosis.*—Face below toruli dark brown (as in Fig. 13); mandibles yellow; hind coxa dark brown (Fig. 11) and hind femur with distal half brown; ss2 setae absent between posterior ocelli (Fig. 85); malar suture absent below eye. Male antenna with scape white, slightly swollen (Fig. 36, 88), with narrow, elongate sensory area containing 2 irregular rows of sensillae extending about 1/3 length.

This is one of the small group of species with a dark face and dark hind coxae. It is most similar to *E. jamicii* which, like *xiomarae*, lacks small setae between the posterior ocelli. *Euplectrus xiomarae* can be separated by the presence of yellow mandibles (mandibles brown in *jamicii*) and lack of a malar suture (malar suture present in *jamicii*).

*Description.*—Female. Body length 1.8–2.2 mm. Color: body mostly black except the following: face below and between toruli brown; antenna with scape yellow, flagellum yellow or light brown; mandibles yellow; legs yellow-brown except hind coxa mostly dark brown, hind femur with distal half brown; dorsal metasoma with large central yellow area extending from just behind petiole posteriorly about 1/2 length of dorsum, becoming darker brown posteriorly, lateral margin brown,

ventral metasoma yellow in anterior half, then dark brown. *Head.* Dorsally with minor seta ss2 absent between posterior ocelli (rarely with 1) (Fig. 85), all setae S1–6 present, setal row sr2 present as 1–2 irregular rows of 8–10 setae reaching the bottom of the eye; occipital carina weak; width of eye: width of face:38:12, posterior margin eye of not nearly contiguous with posterior margin of head over most of length. Ratio of MS:EH 18:28; lateral ocellus more than 1 diameter from eye (OD:OOD 6:10). Face below eyes rounded, not abruptly narrowing. Vertex under anterior ocellus reticulate. Toruli separated by about 2.1× their own diameters. Malar suture absent below eye. Area under eye lightly reticulate. Scape 4× as long as wide. Ratio of funicular segments 12:11:11:11:17, width 6 at F1 to 7 at club, flagellar segments with small whorls of brown setae basally. *Mesosoma.* Pronotum anterior to transverse carina with scattered setae, finely rugosely reticulate, posterior to carina more openly reticulate and shiny. Mesoscutum (Fig. 86) reticulate, becoming more smooth, and shiny posteriorly. Mid-lobe with median carina fading over anterior 1/4, otherwise complete, not noticeably sunken posteriorly, with no small setae antero-laterally, posterior setae even with surface. Dorsal axillar/scutellar margin with broad, nearly straight deep furrow with flat bottom. Axillae shiny, open-

ly reticulate. Scutellum shiny, lightly reticulate to alutaceous, smooth along posterior margin, pointed at anterior margin with axillae. Metanotum bordered anteriorly by a narrow band of small alveoli, medially shiny and lightly reticulate (Fig. 87). Propodeum laterad of median carina lightly reticulate, shiny to the step-like plica, median carina with anterior cup-like flange nearly triangular and invaginated, with transverse carina. Area around spiracle openly reticulate laterally, spiracle slightly raised above surface and slanted so that opening is at a slight angle to the surface, with antero-lateral flange large, obvious, with 9–12 setae laterad and below spiracle. Posterior margin of propodeum without deep alveolus at posterior margin. Petiole in dorsal about as wide as long (12:13), rugose dorsally. *Metasoma*. Ovate, about 1.2–1.5× as long as wide. Legs. Ratio of hind tibial spur 1:spur 2: tarsus 1:T2:T3:T4. 35:26:21:15:10:16. Forewing. Hyaline, about 2.3× as long as wide. Costal cell with 2 irregular rows of setae ventrally. Venation yellow to white, ratio of postmarginal: stigmal (25:18).

*Male*.—Similar to female except: body length 1.9 mm; antenna with scape white, slightly swollen (Fig. 19, 36, 88), with narrow, elongate sensory area containing 2 irregular rows of sensillae extending about 1/3 length; funicle ratios 11:11:13:13:17 width 5–6, with scattered or whorled semierect brown setae on each flagellomere.

*Hosts*.—*Hemiceras clarki*, *H. corema*, *H. nigrescens*, *Rosema attenuata* (all Notodontidae).

*Notes*.—One female specimen has been observed with a single ss2 seta instead of the usual two. This further confirms that there may be some variation in this character although overall it is quite stable.

*Distribution*.—Known only from the ACG.

*Types*.—Holotype female: Costa Rica, Guanacaste Prov., Area de Conservación Guanacaste, Lambert N318500 E359850,

240m., VIII. 20, 1993, 93-SRNP-4388, D.H. Janzen & W. Hallwachs. ex. *Hemiceras clarki* (deposited in INBIO). Paratypes: 3 females with the same data as holotype; other specimens with some of the same information are except: 3 males and 2 females with Lambert N318500 E359850, 240m., VIII. 22. 1992, 92-SRNP-4609; 1 male and 2 females with Lambert N318500 E359850, 240m., VIII. 16. 1993, 93-SRNP-4384; 3 females with Lambert N313500 E359850, 240m., VIII. 22. 1992, 92-SRNP-4614; 1 female with Lambert N318500 E359850, 240m., VIII.23.1992, 92-SRNP-4642; 1 female with Lambert N318500 E359850, 240m., VIII.22.1992, 92-SRNP-4602; 3 females with Lambert N318500 E359850, 240m., VIII. 23. 1992, 92-SRNP-4652, ex. *Rosema attenuata* (deposited in the USNM and BMNH, INBIO, and CNC).

*Etymology*.—This species is named in honor of Xiomara Driggs Valerín in special recognition of her dedicated management of the Human Resources office of the Area de Conservación Guanacaste.

#### *Euplectrus zamorai* Schauff, new species (Fig. 22)

*Diagnosis*.—Face below toruli dark brown or black (as in Fig. 15); mandibles brown; seta S4 and seta ss2 absent (as in Fig. 85); funicle yellow except last two segments dark brown (Fig. 22); malar suture absent below eye; setal line sr2 reduced; anterior metanotum without alveoli; propodeum laterad of median carina smooth.

The contrasting distal antennal segments of this species readily set it apart from similar species such as *orias* and *valverdei* which also have a dark face and dark hind coxae but unicolorous, or only gradually darkening, flagellar segments. *Euplectrus furnius* also has the apical flagellar segments contrasting with F1, but that species has the ocellus more than 2× its diameter removed from the margin of the eye (just over 1× in *zamorai*) and the face is about 4× as wide as the width of the eye (just over 2× in *zamorai*).

*Description.*—Female. Body length 1.7–2 mm. Color: body mostly black except the following: antenna with scape yellow, flagellum yellow, last 2 flagellomeres brown or light brown; mandibles brown; legs yellow except hind coxa brown; dorsal metasoma with large central yellow area extending from just behind petiole posteriorly about 2/3 length of dorsum, becoming darker brown posteriorly, lateral margin brown, ventral metasoma yellow in anterior half, then dark brown. *Head.* Dorsally with minor seta ss2 absent between posterior ocelli, seta S4 absent, setal row sr2 present but reduced to 1 short row of 3–4 setae with an additional seta or two near bottom of eye; occipital carina weak to absent; width of eye: width of face: 33:14, posterior margin eye of not nearly contiguous with posterior margin of head over most of length. Ratio of MS: EH 15:28; lateral ocellus more than 1 diameter from eye (OD:OOD 6:8). Face below eyes abruptly narrowing. Vertex under anterior ocellus reticulate. Toruli separated by about 2× their own diameters. Malar suture absent below eye. Area under eye lightly reticulate to alutaceous. Scape 5× as long as wide. Ratio of funicular segments 12:13:13:12:16, width 5 at F1 to 6 at club, flagellar segments with small whorls of brown setae basally. *Mesosoma.* Pronotum anterior to transverse carina with scattered setae, finely rugosely reticulate, posterior to carina more nearly smooth with slight open reticulation and shiny. Mesoscutum reticulate, becoming more smooth, and shiny posteriorly. Mid-lobe with median carina nearly complete, fading at extreme anterior margin, not noticeably sunken posteriorly, with no small setae antero-laterally, posterior setae even with surface. Dorsal axillar/scutellar margin with narrow, nearly straight deep furrow without flat bottom. Axillae nearly smooth, shiny, with faint open reticulation. Scutellum shiny, very lightly alutaceous, smooth along posterior margin. Metanotum anteriorly nearly contiguous

with scutellum, without obvious narrow band of small alveoli, medially shiny and smooth. Propodeum laterad of median carina shiny and smooth to the step-like plica, median carina with anterior cup-like flange rounded and invaginated. Area around spiracle reticulate, spiracle slightly raised above surface and parallel to the surface, with antero-lateral flange present, with 6–8 setae laterad and below spiracle. Posterior margin of propodeum without deep alveolus at posterior margin. Petiole in dorsal as wide as long (12:12), rugose dorsally. *Metasoma.* Ovate, about 1.1–1.5× as long as wide. Legs. Ratio of hind tibial spur 1:spur 2:tarsus 1:T2:T3:T4. 31:22:22:11:8:14. Forewing. Infusate light brown, about 2.3× as long as wide. Costal cell with 1 irregular row of setae ventrally. Venation yellow light brown, ratio of post-marginal: stigmal (22:13).

*Male.*—Unknown.

*Hosts.*—Unknown.

*Distribution.*—Known only from the type localities.

*Types.*—Holotype female: Costa Rica, Heredia, Chilamate, 75m., XII.1989, III.1989, Hanson & Godoy (deposited in USNM). Paratypes: 2 females with same data as holotype except V. 1989; 1 female IX-X.1989; 1 female Guanac, Est. Pitilla, 9 km S Santa Cecilia, 700m., V.1988, P. Hanson (deposited in USNM).

*Etymology.*—This species is named in honor of Luis Federico Garita Zamora in recognition of his many years of steadfast and enlightened management of field operations and construction management for the Area de Conservación Guanacaste.

#### ACKNOWLEDGMENTS

We thank Tami Carlow for technical assistance. Paul Hanson, Univ. of Costa Rica, kindly allowed us access to his collections of specimens. Drs. G. Zolnerowich, S. Lingafelter, D. Smith and M. Gates reviewed the manuscript and provided many helpful comments. This study was supported by NSF grants BSR 90-24770, DEB 93-06296, DEB 97-05072, BSR 80-11558, BSR 83-07887, and BSR 87-06155. This study would not have been possible without the support of



a number of Lepidoptera systematists and the rearing support of the paracologists cited at <http://janzen.sas.upenn.edu>.

## LITERATURE CITED

- Ashmead, W. H. 1904. Classification of the chalcid flies of the superfamily Chalcidoidea, with descriptions of new species in the Carnegie Museum, collected in South America by Herbert H. Smith. *Memoirs of the Carnegie Museum* 1: i-ix, 225-551.
- Bouček, Z. 1977. Descriptions of two new species of Neotropical Eulophidae (Hymenoptera) of economic interest, with taxonomic notes on related species and genera. *Bulletin of Entomological Research* 67: 1-15.
- Bouček, Z. 1988. *Australian Chalcidoidea (Hymenoptera). A Biosystematic Revision of Genera of Fourteen Families, with a Reclassification of Species*. CAB International. 832 pp.
- Burks, B. D. 1979. Eulophidae, pp. 967-1022. In K. V. Krombein, P. D. Hurd, Jr., D. R. Smith, B. D. Burks, eds. *Catalog of the Hymenoptera in American North of Mexico. Vol. 1. Symphyta and Apocrita (Parasitica)*. Smithsonian Institution Press, Washington, D.C. 1198 pp.
- Coudron, T. A. and S. L. Brandt. 1996. Characteristics of a developmental arrestant in the venom of the ectoparasitoid wasp *Euplectrus comstockii*. *Toxicon* 34: 1431-1441.
- Coudron, T. A. and Puttler, B. 1988. Response of natural and factitious hosts to the ectoparasite *Euplectrus plathypenae* (Hymenoptera: Eulophidae). *Annals of the Entomological Society of America* 81: 931-937.
- Dangerfield, P. C., J. B. Whitfield, M. J. Sharkey, D. H. Janzen and I. Mercado. 1996. *Hansonia*, a new genus of cardiocliline Braconidae (Hymenoptera) from Costa Rica, with notes on its biology. *Proceedings of the Entomological Society of Washington* 98: 592-596.
- DeSantis, L. 1967. *Catálogo de los Himenópteros Argentinos de la Parasítica, Incluyendo Bethyloidea*. Publicación especial. Comisión de Investigaciones Científicas de la Provincia de Buenos Aires. LaPlata, Argentina. 337 pp.
- DeSantis, L. 1979. *Catálogo de los Himenópteros Calcidoideos de América al Sur de los Estados Unidos*. Publicación especial. Comisión de Investigaciones Científicas de la Provincia de Buenos Aires. LaPlata, Argentina.
- DeSantis, L. 1980. *Catálogo de los Himenópteros Brasileños de la serie Parasítica Incluyendo Bethyloidea*. Editora de Universidade Federal do Paraná Curitiba. 395 pp.
- DeSantis, L., and P. Fidalgo. 1994. *Catálogo de Himenópteros Calcidoideos*. Serie de la Academia Nacional de Agronomía y Veterinaria. No. 13. 154 pp.
- Ferrière, C. 1941. New species of Euplectrini (Hym. Chalcidoidea) from Europe, Africa and Asia. *Bulletin of Entomological Research* 32(1): 17-48.
- Gauld, I. D., K. J. Gaston and D. H. Janzen. 1992. Plant allelochemicals, tritrophic interactions and the anomalous diversity of tropical parasitoids: the "nasty" host hypothesis. *Oikos* 65: 353-357.
- Gauld, I. D. and D. H. Janzen. 1994. The classification, evolution and biology of the Costa Rican species of *Cryptophion* (Hymenoptera: Ichneumonidae). *Zoological Journal of the Linnean Society* 110: 297-324.
- Gonzalez, A. 1985. Revision of the genus *Euplectrus* (Hym.—Eulophidae) of the New World. Ph.D. Thesis. University of California, Riverside.
- Howard, L. O. 1880. A new silk-spinning chalcid. *Canadian Entomologist* 12: 158-159.
- Howard, L. O. 1885. Descriptions of North American Chalcididae from the collections of the U.S. Department of Agriculture and of Dr. C. V. Riley, with biological notes. Together with a list of the described North American species of the family. USDA. *Bulletin of the Bureau of Entomology* 5: 5-47.
- Howard, L. O. 1897. On the Chalcididae of the Island of Grenada, B.W.I. *Journal of the Linnean Society, Zoology* 26: 129-178.
- Janzen, D. H. 1993. Caterpillar seasonality in a Costa Rican dry forest. In: *Caterpillars. Ecological and Evolutionary Constraints on Foraging*, N. E. Stamp and T. M. Casey, eds., Chapman and Hall, New York, pp. 448-477.
- Janzen, D. H. 2000. Costa Rica's Area de Conservación Guanacaste: a long march to survival through non-damaging biodevelopment. *Biodiversity* 1: 7-20.
- Janzen, D. H. and I. D. Gauld 1997. Patterns of use of large moth caterpillars (Lepidoptera: Saturniidae and Sphingidae) by ichneumonid parasitoids (Hymenoptera) in Costa Rican dry forest. In: *Forests and Insects*, eds. A. D. Watt, N. E. Stork and M. D. Hunter, Chapman & Hall, London, pp. 251-271.
- Janzen, D. H. and W. Hallwachs. 2000. Philosophy, navigation and use of a dynamic database ("ACG Caterpillars SRNP") for an inventory of the macrocaterpillar fauna, and its food plants and parasitoids, of the Area de Conservación Guanacaste (ACG), northwestern Costa Rica (<http://janzen.sas.upenn.edu>).
- Janzen, D. H., M. J. Sharkey, and J. M. Burns. 1998. Parasitization biology of a new species of Braconidae (Hymenoptera) feeding on larvae of Costa Rican dry forest skippers (Lepidoptera: Hesperidae: Pyrginae). *Tropical Lepidoptera* 9 (Suppl.): 33-41.

- Noyes, J. S. 1998. Catalogue of the Chalcidoidea of the World. *Biodiversity catalogue database and image library CDRom series*. ETI Biodiversity Center, Amsterdam, Netherlands.
- Puttler, B., G. Gordh, and S. H. Long. 1980. Bionomics of *Euplectrus puttleri* Gordh, new species, an introduced parasite of the velvetbean caterpillar, *Anticarsia gemmatalis* from South America. *Annals of the Entomological Society of America* 73:28–35.
- Sharkey, M. J. and D. H. Janzen. 1995. Review of the world species of *Sigalaphus* (Hymenoptera: Braconidae: Sigalaphinae) and biology of *Sigalaphus romeroi*, new species. *Journal of Hymenoptera Research* 4: 99–109.
- Walker, F. 1843. Descriptions of Chalcidites discovered in St. Vincents Isle by the Rev. Lansdown Guilding. *Annals and Magazine of Natural History* 12: 46–49.
- Wijsekara, G. A. W. and M. E. Schauff. 1994. Revision of the tribe Euplectrini of Sri Lanka (Hymenoptera: Eulophidae) *Oriental Insects* 28: 1–48.
- Wijsekara, G. A. W. and M. E. Schauff. 1997. Two new genera and species of Euplectrini (Hymenoptera: Eulophidae) from the New World. *Proceedings of the Entomological Society of Washington* 99: 101–109.
- Zitani, N. M., S. R. Shaw, and D. H. Janzen. 1997. Description and biology of a new species of *Meteorius* Haliday (Hymenoptera: Braconidae, Meteorinae) from Costa Rica, parasitizing larvae of *Papilio* and *Parides* (Lepidoptera: Papilionidae). *Journal of Hymenoptera Research* 6: 178–185.